MECHANICAL ENGINEERING

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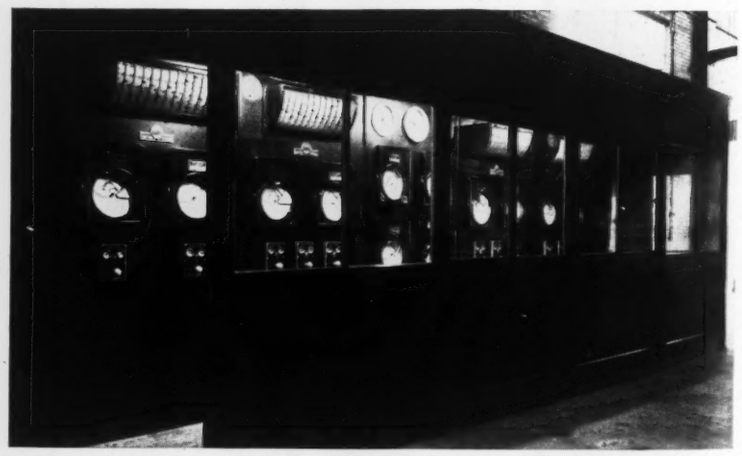

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Auditorium of Engineering Societies Building, New York, N. Y. Ever since 1907 when the Headquarters of the Founder Societies was dedicated, members of The American Society of Mechanical Engineers have assembled in this Auditorium for their annual meetings. This year the meeting will be held at the Bellevue-Stratford Hotel, Philadelphia, Pa., Dec. 4–8. *See pages 842 and 843 for program.*

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MECHANICAL ENGINEERING

NOVEMBER
1939

GEORGE A. STETSON, *Editor*

Enrichment

FOR three centuries the continent of North America has been continuously enriched by millions of immigrants who have come to its shores for a variety of reasons, not the least of which have been the lack of opportunity and the various forms of oppression that have made conditions of life unsatisfactory or even intolerable in the mother countries. During the last quarter century certain aspects of this steady accretion of human and intellectual resources have been dramatic and spectacular. The loss of other nations has been our gain; and in spite of social and economic problems arising out of immigration our net gain has been too real for us to regret the necessity of facing the problems. Certainly, when mechanical engineers survey their literature and investigate the origins of the research workers to whom it is credited, they sense the intellectual enrichment that their own field of endeavor has experienced.

This enrichment is no less real in other fields. As one small example in the field of art attention may be directed to the frontispiece of this issue and to the illustrations accompanying the article "The A.S.M.E. Today," which have been reproduced from pencil drawings made by Lili Réthi, whose work is well known to artists, architects, and engineers in Europe. Miss Réthi, whose drawings have frequently illustrated European books and periodicals and have been accorded particular notice by European engineers, has found in engineering structures and construction work, as well as in cathedrals, churches, and beautiful architecture, subjects that appeal to her artistic sensibilities. Engineers, who are commonly assailed for introducing much ugliness into the world, should be grateful to an artist who can see beauty in their works, and who can interpret that beauty in a way that laymen can appreciate. If her work in this country continues to perform this service for engineers, one more example of the cultural enrichment of America can be placed on the record.

Metal-Cutting Data

FOR a nation that is wiping the slush oil off new and stored machine tools and is stepping up its production schedules to what may be a wartime tempo, the publication by The American Society of Mechanical Engineers of a "Manual on Cutting of Metals" is a timely event. When it gets to be a question of pushing machines and tools to the limit of performance on the production of essentials that cannot be delayed, this 300-page manual of shop-tested information on speeds and feeds that can be used with various depths of cut in machining all of the common and alloy steels in ordinary use will become one of the most important of shop tools. For it has been prepared to be used in the shop, and where the information it contains has been so used, improvement in shop performance has ranged from 10 to 25 per cent better than everyday good shop practice.

Since the pioneering work of Frederick W. Taylor, made public in his classic address "On the Art of Cutting Metals" in 1906 when he was president of The American Society of Mechanical Engineers, numerous investigators have carried on researches in the same and allied fields. All of these sources of information were studied by the A.S.M.E. Committee on Metal Cutting Data which prepared the Manual just published. Where gaps in the information appeared, the committee carried on experimental work on the cutting of cast iron and steel to fill them. Important facts or laws relating to metal cutting were determined from the correlated experiments and published data, and extensive tables, which form a considerable portion of the Manual, were prepared.

It is difficult to see how a machine shop of any importance can afford to be without this up-to-date and complete Manual, not only to check its own practices but to improve them wherever this is shown to be possible and to guide production schedules for new work to be undertaken. As a worthy continuation of the work initiated by Taylor more than 30 years ago, a work which brought international attention and prestige to The American Society of Mechanical Engineers, the present Manual is destined to mark an important epoch in the art of cutting metals.

Forty Plus

PROBABLY few members of The American Society of Mechanical Engineers more than 40 years of age, and this age group is a considerable proportion of the total Society membership, have not experienced at least a mild form of panic at the thought of what they might do for themselves if they lost their jobs. To others the experience has been a stark reality that has resulted in various degrees of success or failure. To the entire country the problem of the unemployed man over forty is a challenge, and unless the challenge is successfully met, the problem will grow more serious as time goes on. Meanwhile the casualties are a reproach to our economic system that charity and social-security plans may alleviate but cannot cure. For the only cure worthy of a satisfactory eco-

nomic system is the useful employment of every competent person who needs or desires it at some task worthy of his abilities and of a nature that will make him reasonably happy. How this is to be accomplished has not yet developed, but attempts to effect it have been made.

In so far as engineers are concerned, one such attempt is being made by the Engineering Societies Employment Service, with headquarters in New York and branch offices in Chicago and San Francisco, operated jointly by the Founder Societies. It is no secret that the problem of the man over forty is one of the toughest the Service has to face. In the solution of that problem employers of engineers can be of assistance by making use of the Service when opportunity to use the talents of engineers presents itself.

Another venture, which started in Boston and has spread to other cities, including New York, is the Forty Plus Club, a unique form of organization through which men of the executive type, over forty and formerly active at salaries in excess of $4000 and in positions in the fields of finance, production, management, sales, and the like, work cooperatively to find jobs for fellow members. These men are actively engaged in some phase of the organization's work and thus continue to exercise functions commonly employed in business. The success of the venture may be gaged in a measure by the experience of the New York club which, starting in January, 1939, with 27 members, is said to have a membership in excess of 200 and an "alumni" body of more than 60 men whose return to industry has been accomplished.

Such worthy projects as the Engineering Societies Employment Service and the Forty Plus Club deserve the support of employers. They present no universal or final cure for the unemployed at forty plus, but they are based on a sound principle-cooperative self-help. The world has discovered no sounder way toward social progress.

What About Engineers' Unions?

WITH the passage of the National Labor Relations Act and the setting up of the NLRB, it became evident that trades unions had an implied sanction by government to take over negotiations between employee and employer on matters relating to wages and working agreements in general. That the unions were quick to seize the opportunity thus afforded them is a matter of recent and present-day history. Much has been said and written on innumerable phases of the changed conditions, and criticism of the manner in which union leaders have handled the responsibilities of their office has caused many bitter controversies.

It has appeared to many persons that union leaders were taking advantage of a favorable opportunity to overstep the bounds of reason in their efforts to strengthen the power of the unions and their own control of the unions themselves and the free choice of men who, for one reason or another, preferred not to submit to their domination. Struggle for control has split the ranks of labor itself, and in the general free-for-all situations have developed in which individuals and minority groups have been forced to go along with the crowd or be threatened with loss of employment or even with personal violence. Moreover, the movement has been so infectious that groups not normally ripe for unionization have been "organized" in many cases from without, and their members placed in the position of labor when, in effect, they are more closely allied with the professions. In many localities, for example, engineers have had to face the problem of signing up with a union, although by tradition and temperament the objectives and tactics of unions are not agreeable to them.

So confused and yet so important has the question of the unionization of engineers become that a committee of The American Society of Mechanical Engineers has considered the time ripe for a discussion of it. To initiate this discussion, James H. Herron, past-president of the Society, has prepared a statement of the background of the problem and some comments on his own views regarding it. Mr. Herron's statement, which appears in this issue, attempts to outline the essential difference in objective and point of view of unions on the one hand and a profession on the other. He does not claim to have done more than open the subject for debate. He does invite the opinions of others who may agree or disagree with him in the interest of a free and fair discussion of a subject that causes much confusion and concern among younger engineers. It is expected that contributions to the discussion presented in good faith and with constructive intent, will be published in subsequent issues of MECHANICAL ENGINEERING. In issuing a general invitation to engineers to take part in this discussion, the editors plead for concise and constructive statements.

Thurston Centenary

ROBERT Henry Thurston, the centenary of whose birth is being celebrated at Cornell during the last week in October, was one of those men whose services to engineering education have been responsible for the high regard in which it is held today. His name is indelibly associated with the Stevens Institute of Technology and of Sibley College at Cornell. He provides the initial link between engineering education and The American Society of Mechanical Engineers, for he was the first president and one of the founders of the Society. The qualities of his mind and the breadth of his interests set a high standard for the Society. In research, in engineering practice, in education he worked to enrich each of these fields with what he gleaned from the others. The ideals and objectives he set up for the infant society of mechanical engineers are still valid. Clear-sighted vision of what progress in engineering might offer in the immediate future and the sound perspective of his view of contemporary events gave to his presidential addresses a quality that makes them good reading today after a lapse of 60 years. Without detracting from the credit due many others who have served engineering education and The American Society of Mechanical Engineers we are justified in honoring him and hoping that his example will continue to be followed by educators and engineers.

ECONOMIC FACTORS *of the* HOUSING PROBLEM

By JOHN ELY BURCHARD

DIRECTOR, ALBERT FARWELL BEMIS FOUNDATION, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THIS paper is devoted to an effort to establish some methods of determining the potential influence of various economic factors on the solution of the housing problem. It is simple enough to state the problem itself. Most people of the United States are unwilling that a large number of individuals shall live under shelter conditions which some have declared to be substandard. If the standard of shelter conditions has not been set too high by the latter, it follows that the large number either live under substandard conditions through sheer willfulness (which we do not believe) or because they have not enough money to pay for standard housing. Since most of us have decided we do not wish this condition to continue, the problem becomes one of what to do about it.

There are, of course, many opinions as to what to do about it and altogether too many advocates of one or another solution are inclined to pin full faith on that solution. Thus we hear that the crux of the problem is the unearned increment on land, resulting in excessive land valuation; or high financing costs which are almost extortionate; or wasteful and costly municipal government with the severe tax load it lays on shelter units; or the archaic practices of the building industry, which result in costs per unit of product entirely inconsistent with the costs of any other product one might name at random. Others say that no matter what we do about high land values, high interest rates, high taxes, and high construction costs, subsidy is the only true solution.

The author does not propose to attempt to place actual values on the effect of each of these factors on the problem of shelter for the lower-income groups. The procedure will be to develop curves which indicate how the possible effect of any one of the factors may be studied. During the course of this exposition certain tentative conclusions, amounting to generalizations, will be drawn and finally one general conclusion. The studies must necessarily be based upon statistics, which have come from generally reliable sources.

INCOME OF FAMILIES IN THE UNITED STATES

First, let us consider the percentage of all families in the United States which receive certain amounts of family income. These have been reported, by income groups, in two recent critical years, 1929[1] and 1935–1936.[2] These figures have been plotted in Figs. 1 and 1A, showing as ordinates the percentage of families in the nation which in the year in question enjoyed annual incomes in excess of the dollar amounts plotted as the corresponding abscissas.

In Fig. 1, which will be the principal source of reference, the upper limit of each income group has been used. Evidently this paints a more optimistic picture of possible housing than using the mid-values of each income class. If one must choose, it is conservative to choose the upper limit. By those to whom this is unsatisfactory, a grimmer set of conclusions may be drawn by referring to the tables and charts which, employing the same methods as those used in the text, are based on the mid-values. For convenience they are tabulated and plotted with numbers corresponding to the primary tables and charts and identified with a suffixed A. They are not discussed in the text. In either case, as we should expect, the income picture was happier in 1929, though the general shapes of the curves are substantially similar.

Leaving the chart for the moment, consider if you will a family of a specific annual income I, which is ready to devote a percentage s of that income to shelter.[3] If this be the case, there is a definite equation which we may write

$$P = Is/R \qquad [1]$$

where P is the capital value of the new shelter unit which the family can command, and R is the economic rent. At this point a few definitions are evidently required, as follows:

P includes the cost of both land and buildings.[4]

R is expressed as a percentage of P and will consist of the sum of percentages allotted to return on capital,[5] maintenance, depreciation and obsolescence, taxes, insurance, administration and services, and vacancies and bad accounts.

We shall define a shelter unit as new while it is still in its original term of amortization, as provided by the annual charges for depreciation and obsolescence.[6]

---

[1] "America's Capacity to Consume," report of The Brookings Institution, Washington, D. C., 1934, p. 227, Table 37, "Estimated number of families and unattached individuals by income classes, 1929."

[2] "Consumer Incomes in the United States," report of the National Resources Committee, Washington, D. C., 1938, p. 6, table 2, "Distribution of families and single individuals and of aggregate income received, by income levels, 1935–1936." Class intervals are not identical in references (1) and (2), but are sufficiently close for the purpose.

Presented at the twelfth national meeting, Boston, Mass., Oct. 12–13, 1939, of the Wood Industries Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[3] Whether rented or owned makes no difference.

[4] There are substantial individual deviations in the ratio of one of these elements to the other. Estimates of the average ratio are in sufficient agreement to warrant us in using the general ratio of 20 per cent for land and 80 per cent for buildings, particularly as this affects no major inference we may draw.

[5] This item may or may not be solely interest. Generally it is interest only. It may be expressed as a fixed percentage of the original investment, though the value of the investment is steadily declining, *provided* the percentage allotted for annual amortization is established on the basis of a uniform annual payment compounded at the same rate of interest as that charged on the original investment to equal the original investment at the end of the amortization period. This amounts to maintaining a loan on the entire original investment for the full amortization period and meanwhile building up a sinking fund through annual payments at the same rate of interest. It will make the interest charge appear higher and the depreciation charge appear lower. It should be noted that these charges must be included whether or not the individual has in fact borrowed money to finance his shelter unit. If he has loaned the money to himself, he has presumably suffered a loss of income equivalent to the going rate.

[6] Thus under some of the older forms of financing, a unit might be new for 25 years, while under USHA practices the shelter unit may be new for 60 years. Newness in this sense has no relation to the number of different occupants the shelter unit may have had any more than the figures set down make any important discrimination between home owner and tenant.

RELATION OF HOUSING STANDARD TO FAMILY INCOME

Evidently, if we may assume that the standard of a shelter unit will vary roughly with its capital value P, then the standard of housing which a given family can enjoy without help of some sort will be a direct function of the family income, a direct function of the per cent of that income a family is willing or able to expend for shelter, and an inverse function of the economic rent. The variations in family incomes already have been indicated in Figs. 1 and 1A.

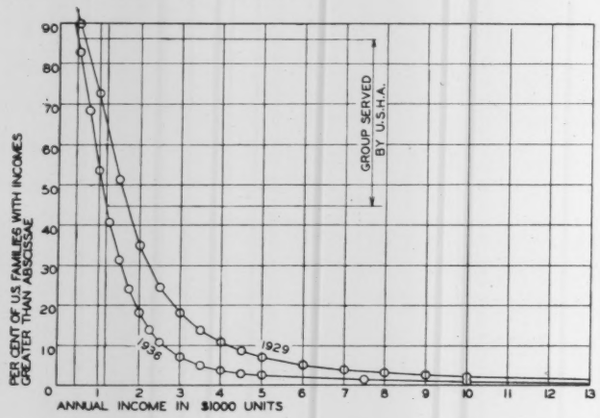

FIG. 1 PERCENTAGE OF FAMILIES IN UNITED STATES RECEIVING CERTAIN AMOUNTS OF FAMILY INCOME, USING UPPER LIMIT OF EACH INCOME GROUP

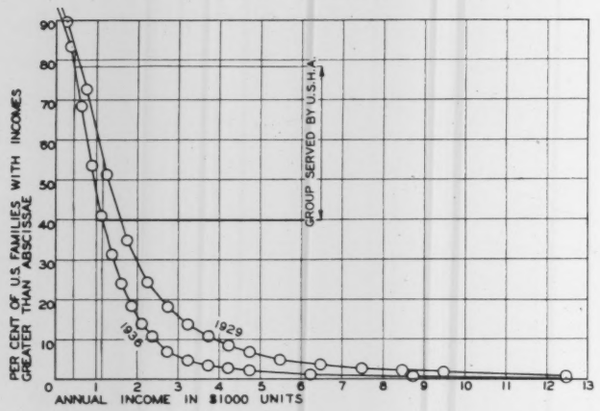

FIG. 1A PERCENTAGE OF FAMILIES IN UNITED STATES RECEIVING CERTAIN AMOUNTS OF FAMILY INCOME, USING AVERAGE VALUE OF EACH INCOME GROUP

The value of s varies substantially between income groups and, within income groups, between cautious and extravagant families. It has also varied substantially through the years.[7] Higher-income groups in general allot larger percentages of the family income to shelter than do lower-income groups, but there is no positive evidence as to how the variation occurs quantitatively. A more careful computation than is made in Tables 2 and 3, 2A and 3A, might attempt to take care of this deviation. For the demonstration in hand, it seems that using a flat value of 20 per cent for all income groups will cause no appreciable and avoidable error pertinent to our purposes. Thus s becomes a constant.

The value of R, on the other hand, can be made to vary substantially. It is in this factor, for example, that variations in the prevailing interest rate will have their effect. If it were desirable to study the effect of interest rate alone, one would keep the other elements of economic rent constant while varying the interest rate. Here also the effect of taxes may be studied, the effect of differing periods of amortization, of indeed each element which adds up to make economic rent. For the purposes of this exposition, the author has developed four different possible economic rents in Table 1.

TABLE 1 POSSIBLE VALUES OF ECONOMIC RENT

(Per cent of original capital value of shelter unit)

	Pre-1930	1939 Private	USHA with taxes	USHA tax-exempt
Capital return[a]	6.0	4.0	2.3	2.3
Maintenance[b]	2.0	2.0	1.5	1.5
Depreciation and obsolescence[c]	2.0	2.0	0.8	0.8
Taxes[d]	2.5	2.5	2.5	0.0
Insurance[e]	0.2	0.2	0.2	0.2
Administration and services[f]	0.6	0.6	1.0	1.0
Vacancies and bad debts[g]	0.7	0.7	0.0	0.0
Totals	14.0	12.0	8.3	5.8

[a] Three values have been assumed:

(a) The usual value before the depression	6	per cent
(b) The present value for large prime mortgages	4	per cent
(c) The present value for long-term government borrowings	2.3	per cent

[b] For single-family frame houses, the prevailing type of American housing, 2 per cent. For single-family brick houses the value might drop to 1.5 per cent. For apartments, where demands may be higher and occupancy changes require frequent renovation, 2.5 per cent. For government housing it has been assumed that quality construction might reduce the charge to 1.5 per cent.

[c] In the first column, the figure of 2 per cent corresponds to just under a 24-year amortization period with annual payments earning 6 per cent in accordance with conservative figuring of another day. In the second column, the 2 per cent represents a 30-year amortization at 3.5 per cent; while the last two columns show 0.8 per cent, a 60-year amortization at the rate of 2.3 per cent. This is a very low obsolescence rate indeed and of course assumes no very drastic changes in living habits or housing standards over the next half century.

[d] It is hard to write an actual value. It is obvious that the current trend is upward and hence likely to increase the economic rent. They are held constant in the table at 2.5 per cent or a $25 per M rate on a full assessment. Subsidized projects are tax-exempt. We have shown their economic rent both ways for reasons which will appear.

[e] Insurance is kept constant in all computations at 0.2 per cent.

[f] Administration and services may vary from nothing for an owner to 1 to 2 per cent for a de luxe apartment. Except in those parts of Table 1 which deal with the USHA, we have charged 0.6 per cent, a fairly usual figure. In the latter case, we have made a frank guess of 1 per cent, in the absence of any information. This seems to us conservatively low in view of the known administration costs, both locally and in Washington. Housing-project management in itself should not be cheap.

[g] Vacancies and bad debts may never cost an owner anything. But, if he has to sell and cannot sell immediately, he may find that the costs for the interim period divided over the years of his ownership result in a charge not far different from the 0.7 per cent applied in the management of an apartment or tenement. We have probably leaned over backward in assuming that government projects will never have a vacancy and never fail to recover on a bad check, and never have to write off any tenant's rent.

Imposing these values of R,[8] and our assumed fixed value of 20 per cent for s, on the income-group curves developed in Figs. 1 and 1A, we may determine for any given income group the highest capital value P of the new shelter unit the group in question can afford. In these computations, both sets of

[7] "The Evolving House," by Albert Farwell Bemis, Mass. Inst. of Technology, Cambridge, Mass., 1934, vol. 2, chap. 3, p. 99, "The annual cost of shelter;" p. 105, chart 19, "Percentage distribution of wage-earners' family budgets compared with those for higher-income groups in the United States;" and p. 107, chart 20, "Percentage distribution of expenditures of wage-earners' families in the United States in various years."

[8] The value of 14 per cent for R is omitted from the computations as being archaic.

income figures have also been used. For 1935–1936, Table 2 shows the value of P obtained by using the upper limit of each income group and Table 2A the value obtained by using the average for each group. Similarly for 1929, Tables 3 and 3A use the upper income figure and the average income figure, respectively, for each group.

TABLE 2 PER CENT OF UNITED STATES FAMILIES AND SINGLE INDIVIDUALS WHO CAN AFFORD NEW SHELTER OF VARIOUS CAPITAL VALUES FOR VARIOUS ECONOMIC RENTS, 1935–1936; BASED ON UPPER INCOME LIMIT

Income level[a]	Families in group,[a] per cent	Families with larger incomes, per cent	Value of P for this income ($P = 0.2\ I/R$) $R = 12\%$[b]	$R = 8.3\%$	$R = 5.8\%$
Under $250	5.4	94.6	$ 415	$ 600	$ 860
$ 250– 500	11.6	83.0	835	1210	1720
500– 750	14.6	68.4	1250	1810	2590
750– 1000	14.9	53.5	1670	2410	3450
1000– 1250	12.7	40.8	2080	3010	4310
1250– 1500	9.5	31.3	2500	3610	5170
1500– 1750	7.3	24.0	2920	4220	6030
1750– 2000	5.8	18.2	3330	4820	6900
2000– 2250	4.3	13.9	3750	5420	7760
2250– 2500	3.2	10.7	4170	6020	8620
2500– 3000	3.7	7.0	5000	7230	10300
3000– 3500	2.2	4.8	5830	8430	12100
3500– 4000	1.3	3.5	6670	9640	13800
4000– 4500	0.7	2.8	7500	10800	15500
4500– 5000	0.5	2.3	8330	12000	17200
5000– 7500	1.0	1.3	12500	18100	25900
7500–10000	0.6	0.7	16700	24100	34500
10000–15000	0.4	0.3	25000	36100	51700
15000–20000	0.2	0.1	33300	48200	69000

[a] Based on reference (2). Incomes of over $20,000 are not included in this table.

[b] Evidently these values of what a family can afford do not reconcile very well with the popular doctrine that a family can afford a house costing twice its annual income, if conservative, and even up to three times. Many families can and do. If they do, it means either that they are allotting a larger percentage than 20 per cent to rent, or are cutting one or another factor out of the economic rent, usually those charged for maintenance and obsolescence. Higher-income groups of course have more flexibility.

TABLE 2A PER CENT OF UNITED STATES FAMILIES AND SINGLE INDIVIDUALS WHO CAN AFFORD NEW SHELTER OF VARIOUS CAPITAL VALUES FOR VARIOUS ECONOMIC RENTS, 1935–1936; BASED ON AVERAGE INCOME

Annual average income of group[a]	Families in group,[a] per cent	Families with more than this income, per cent	Value of P for this income ($P = 0.2\ I/R$) $R = 12\%$	$R = 8.3\%$	$R = 5.8\%$
$ 125	5.4	94.6	$ 210	$ 300	$ 430
375	11.6	83.0	625	905	1290
625	14.6	68.4	1040	1500	2160
875	14.9	53.5	1460	2110	3020
1125	12.7	40.8	1880	2710	3880
1375	9.5	31.3	2290	3310	4740
1625	7.3	24.0	2710	3920	5600
1875	5.8	18.2	3130	4520	6470
2125	4.3	13.9	3540	5120	7330
2375	3.2	10.7	3960	5720	8190
2750	3.7	7.0	4580	6630	9480
3250	2.2	4.8	5420	7830	11200
3750	1.3	3.5	6250	9040	12900
4250	0.7	2.8	7080	10200	14700
4750	0.5	2.3	7920	11400	16400
6250	1.0	1.3	10400	15100	21600
8750	0.6	0.7	14600	21100	30200
12500	0.4	0.3	20800	30100	43100
17500	0.2	0.1	29200	42200	60300

[a] Based on reference (2). For example, the income of $375 is the average of the income group $250–$500. Incomes above $20,000 are not included in this table.

TABLE 3 PER CENT OF UNITED STATES FAMILIES AND UNATTACHED INDIVIDUALS WHO CAN AFFORD NEW SHELTER OF VARIOUS CAPITAL VALUES FOR VARIOUS ECONOMIC RENTS, 1929; BASED ON UPPER INCOME LIMIT

Income level[a]	Families in group,[b] per cent	Families with larger incomes, per cent	Value of P for this income ($P = 0.2\ I/R$) $R = 12\%$	$R = 8.3\%$	$R = 5.8\%$
Under 0	0.4	99.6	..	..	..
$ 0–$ 500	9.8	89.8	$ 835	$ 1210	$ 1720
500– 1000	17.3	72.5	1670	2410	3450
1000– 1500	21.3	51.2	2500	3610	5170
1500– 2000	16.4	34.8	3330	4820	6900
2000– 2500	10.5	24.3	4170	6020	8620
2500– 3000	6.2	18.1	5000	7230	10300
3000– 3500	4.4	13.7	5830	8430	12100
3500– 4000	3.0	10.7	6670	9640	13800
4000– 4500	2.2	8.5	7500	10800	15500
4500– 5000	1.6	6.9	8330	12000	17200
5000– 6000	2.0	4.9	10000	14500	20700
6000– 7000	1.2	3.7	11700	16900	24100
7000– 8000	0.8	2.9	13300	19300	27600
8000– 9000	0.5	2.4	15000	21700	31000
9000–10000	0.4	2.0	16700	24100	34500
10000–15000	1.0	1.0	25000	36100	51700
15000–20000	0.4	0.6	33300	48200	69000

[a] Based on reference (1). Incomes of over $20,000 are not included in this table.

[b] Based on reference (1), p. 228, Table 38, "Percentage distribution of families and unattached individuals by income classes, 1929."

TABLE 3A PER CENT OF UNITED STATES FAMILIES AND UNATTACHED INDIVIDUALS WHO CAN AFFORD NEW SHELTER OF VARIOUS CAPITAL VALUES FOR VARIOUS ECONOMIC RENTS, 1929; BASED ON AVERAGE INCOME

Annual average income of group[a]	Families in group,[b] per cent	Families with more than this income, per cent	Values of P for this income ($P = 0.2\ I/R$) $R = 12\%$	$R = 8.3\%$	$R = 5.8\%$
0	0.4	99.6	..	..	..
$ 250	9.8	89.8	$ 415	$ 600	$ 860
750	17.3	72.5	1250	1810	2590
1250	21.3	51.2	2080	3010	4310
1750	16.4	34.8	2920	4220	6030
2250	10.5	24.3	3750	5420	7760
2750	6.2	18.1	4580	6630	9480
3250	4.4	13.7	5420	7830	11200
3750	3.0	10.7	6250	9040	12900
4250	2.2	8.5	7080	10200	14700
4750	1.6	6.9	7920	11400	16400
5500	2.0	4.9	9170	13300	19000
6500	1.2	3.7	10800	15700	22400
7500	0.8	2.9	12500	18100	25900
8500	0.5	2.4	14200	20500	29300
9500	0.4	2.0	15800	22900	32800
12500	1.0	1.0	20800	30100	43100
17500	0.4	0.6	29200	42200	60300

[a] Based on reference (1). For example, the income figure $250 is the average of the group 0 to $500. Incomes above $20,000 are not included in this table.

[b] Based on reference (1), p. 228, Table 38.

The important parts of these tables have been charted with ordinates representing the percentage of families which can afford new shelter units of a cost equal to or exceeding the corresponding abscissas.[9] Figs. 2 and 3 show upper income figures for each group in 1935–1936 and 1929, and Figs. 2A and

[9] The cost evidently also applies to old shelter units. In fact, because it does is the only reason numbers of the people are housed at all. But it is impossible to determine the exact value of old housing units within the frame of this discussion. Later study may permit superimposition on these values of curves representing depreciating values of shelter units to make the picture clearer. It is obviously not satisfactory to talk only of new shelter units though that is the phrase commonly used by the reformer.

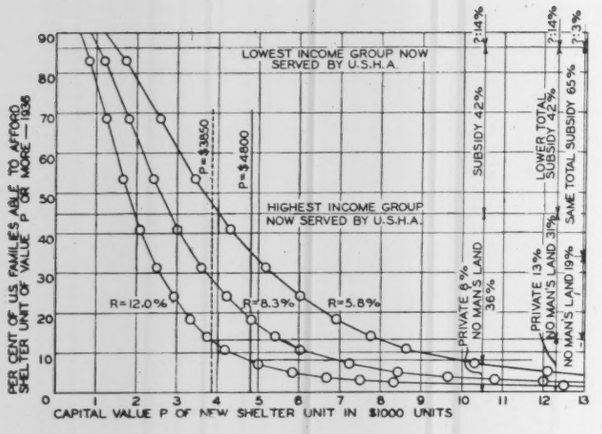
LOWEST INCOME GROUP NOW SERVED BY U.S.H.A.
HIGHEST INCOME GROUP NOW SERVED BY U.S.H.A.
P=$3850
P=$4800
R=12.0%
R=8.3%
R=5.8%
SUBSIDY 42%
PRIVATE 8%
NO MAN'S LAND 36%
LOWER TOTAL SUBSIDY 42%
PRIVATE 13%
NO MAN'S LAND 31%
SAME TOTAL SUBSIDY 65%
NO MAN'S LAND 19%
PER CENT OF U.S. FAMILIES ABLE TO AFFORD SHELTER UNIT OF VALUE P OR MORE—1936
CAPITAL VALUE P OF NEW SHELTER UNIT IN $1000 UNITS

FIG. 2 PERCENTAGE OF FAMILIES IN UNITED STATES ABLE TO AFFORD SHELTER UNIT OF P VALUE OR MORE, 1935–1936; BASED ON UPPER INCOME LIMIT

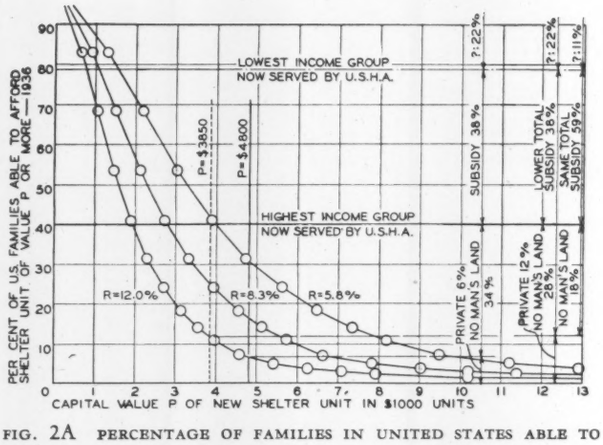
LOWEST INCOME GROUP NOW SERVED BY U.S.H.A.
HIGHEST INCOME GROUP NOW SERVED BY U.S.H.A.
P=$3850
P=$4800
R=12.0%
R=8.3%
R=5.8%
SUBSIDY 38%
PRIVATE 6%
NO MAN'S LAND 34%
LOWER TOTAL SUBSIDY 36%
PRIVATE 12%
NO MAN'S LAND 28%
SAME TOTAL SUBSIDY 59%
NO MAN'S LAND 18%
PER CENT OF U.S. FAMILIES ABLE TO AFFORD SHELTER UNIT OF VALUE P OR MORE—1936
CAPITAL VALUE P OF NEW SHELTER UNIT IN $1000 UNITS

FIG. 2A PERCENTAGE OF FAMILIES IN UNITED STATES ABLE TO AFFORD SHELTER UNIT OF P VALUE OR MORE, 1935–1936; BASED ON AVERAGE INCOME LEVEL

3A the average figures for each income group in 1935–1936 and 1929.

Examination of these charts now shows that the percentage of families which can afford a given standard of housing is a function (though not linear) of the cost of that housing. As a starting point let us use the cost of a shelter unit of the USHA.[10]

COST OF UNITED STATES HOUSING AUTHORITY PROJECTS

The latest annual report of that organization gives us the estimated costs of USHA projects covered by approved loan contracts for 140 projects in very complete form.[11] These are reported in such a way that it is possible to compute the average, $5100, for 64,451 dwelling units, and the median, $4810,[12] hereafter called $4800.

For our purposes we shall select the median value.[13] It is but fair to add the Authority reports that actual costs are usually lower than costs indicated by approved loan contracts.

If in Fig. 2 we project the vertical line $P = \$4800$ to its intersections respectively with the curves $R = 12$ per cent, $R = 8.3$ per cent, and $R = 5.8$ per cent, we can make some interesting observations.

Where the curve $R = 12$ per cent intersects $P = \$4800$, the ordinate of 8 per cent indicates that only 8 per cent of our families can expect to command new shelter units of this value even with an interest rate of but 4 per cent.

If we drop the interest rate to 2.3 per cent, i.e., finance shelter units through government bonds, and if we amortize on a 60-year basis (see Table 1 for full particulars), we can increase this percentage to 19 per cent. In other words, there is a zone of about 11 per cent which might be housed through low-interest-bearing long-term government loans without subsidy. If we add the feature of tax exemption, a further 16 per cent can be housed without other subsidy than this.

Let us indicate on Fig. 2 the groups which are now permitted to rent in USHA projects. The lower income limit, as set by the Authority in its report, is $450 per annum, the upper limit is $1150.[14] By projecting these two amounts on the chart Fig. 1 to their intersections with the 1935–1936 income curve, we note that the lower possible income corresponds to an ordinate of 86 per cent and the higher possible income to an ordinate of 44 per cent. It is between these two percentages that the present subsidy area of the USHA lies. Potentially, on the basis of 1935–1936 incomes, it embraces 42 per cent of the families of the United States. These ordinates can be carried over to Fig. 2 and the corresponding ordinates, derived from use of the 1929 curve of Fig. 1, can be carried over to Fig. 3.

Between the highest-income group touched by USHA and the highest-income group economically able to occupy the shelter unit through low-return government loan with tax exemption there is an area which may be called no man's land. This area on the chart Fig. 2, at a minimum, comprises 9.5 per cent of the families. Since there is no existing mechanism for low-return government-loan tax-exempt housing, or indeed any nonsubsidized housing, at an economic rent below the 12 per cent level, the actual no man's land evidently covers three zones totaling 36 per cent.

Let us recapitulate. If the new shelter unit costs $4800 on the basis of present income distributions, the following percentages of the 40,000,000 families may or may not enjoy new shelter: Hopeless, 14 per cent; USHA subsidy, 42 per cent; no man's land, 36 per cent; and private, 8 per cent.

[10] This is selected primarily because the recent report of the USHA offers perhaps the most complete costs yet available for a large number of shelter units, and not for the purpose of discussing the USHA program exclusively.

[11] "Annual Report of the United States Housing Authority," Washington, D. C., 1938, pp. 13–17, Table 4 "Estimated cost of USHA-aided projects covered by approved loan contracts (as of Dec. 31, 1938)."

[12] In a recent article and in several speeches Mr. Nathan Straus has made a plea for a number of deductions from the over-all cost of the dwelling units built under USHA. With his plea to omit the costs of slum clearance it is possible to be sympathetic and this deduction is made in our computations. On the other hand, his argument for the deduction of the item "non-dwelling facilities" is less clear. It seems evident that a number of items ordinarily charged to land development are included in this rather than in the column for land costs. If not, the USHA succeeded in buying its land at a median cost per dwelling unit which is but 6 per cent of the median total cost per unit. This is very far out of line with usual practice. On the other hand, the median value of both land and non-dwelling facilities approximates the usual 20 per cent. Mr. Straus argues that some of the things provided in housing projects such as recreation are not provided by the speculative builder. We cannot agree to his premises and non-dwelling facilities are included in the total.

[13] There is no special logical reason for this selection. The top figure of $6330 and the bottom figure of $2938 are not the centers of clusters, nor is either so far from the norm as to cause a serious discrepancy in the arithmetical average. As a matter of fact, an average might be better. A modal figure would apparently mean nothing for there are several modal humps at levels corresponding apparently to different geographical, climatic, or racial conditions. This correspondence is not exact. Texas projects are cheap. Louisiana's are costly. New York's with one exception are by no means so much more expensive than those of the rest of the nation.

[14] Reference (11), p. 6, Table 2, "Estimated average rent and income groups to be reached in USHA-aided projects covered by approved loan contracts (as of Dec. 31, 1938)."

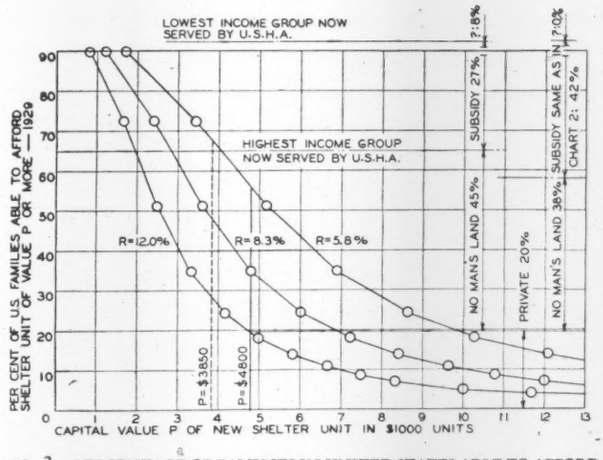
LOWEST INCOME GROUP NOW SERVED BY U.S.H.A.
HIGHEST INCOME GROUP NOW SERVED BY U.S.H.A.
SUBSIDY 27%
NO MAN'S LAND 45%
PRIVATE 20%
NO MAN'S LAND 38%
SUBSIDY SAME AS IN CHART 2: 42%
R=12.0%
R=8.3%
R=5.8%
P=$3850
P=$4800
PER CENT OF U.S. FAMILIES ABLE TO AFFORD SHELTER UNIT OF VALUE P OR MORE — 1929
CAPITAL VALUE P OF NEW SHELTER UNIT IN $1000 UNITS

FIG. 3 PERCENTAGE OF FAMILIES IN UNITED STATES ABLE TO AFFORD SHELTER UNIT OF P VALUE OR MORE, 1929; BASED ON UPPER INCOME LIMIT

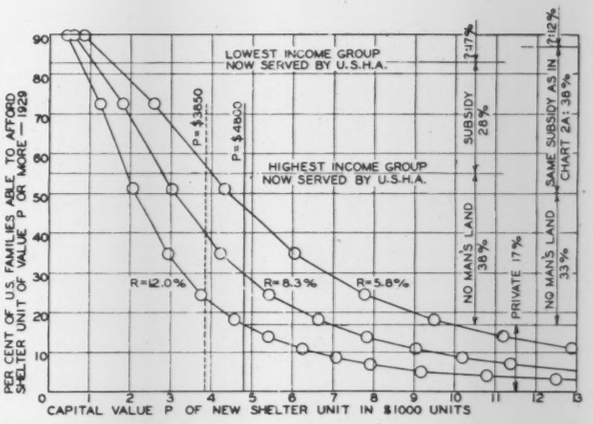
LOWEST INCOME GROUP NOW SERVED BY U.S.H.A.
HIGHEST INCOME GROUP NOW SERVED BY U.S.H.A.
SUBSIDY 28%
NO MAN'S LAND 38%
PRIVATE 17%
NO MAN'S LAND 33%
SAME SUBSIDY AS IN CHART 2A: 38%
R=12.0%
R=8.3%
R=5.8%
P=$3850
P=$4800
PER CENT OF U.S. FAMILIES ABLE TO AFFORD SHELTER UNIT OF VALUE P OR MORE — 1929
CAPITAL VALUE P OF NEW SHELTER UNIT IN $1000 UNITS

FIG. 3A PERCENTAGE OF FAMILIES IN UNITED STATES ABLE TO AFFORD SHELTER UNIT OF P VALUE OR MORE, 1929; BASED ON AVERAGE INCOME LEVEL

It may be well to examine two of the implications of this. First, what of those who are said to be in no man's land? Does it follow that they are ill-housed? Can we conclude from a mere chart that all the families with incomes between $1150 and $2900 are ill-housed? We know from personal experience that the conclusion would be ridiculous. The reconciliation varies with the income group. Substantial numbers can be housed in buildings which are no longer new. If a building is amortized in 25 years, it then stands as worth nothing but it may of course still be good shelter. Actually, the full amortization is not taken, but a second period begins in which the shelter unit is revalued. Low incomes mean also that many people have suffered real-estate losses. Many of the group are occupying properties worth more than it is costing them, someone else having been squeezed. Finally, at the upper limits of the group many may in fact own new shelter units costing more than $4800. In such cases they are actually devoting more than 20 per cent of their family budget to shelter, although, by deferring maintenance charges, by not setting up reserves for depreciation, and by writing off any return on their equity, they may actually pay much less out of pocket. It is indeed this kind of financing by the homeowner which has made so much home ownership possible and, in the face of charts such as these, it must give us pause as to the real economic truths of home ownership.

COST TO THE COUNTRY OF USHA PROGRAM

Again, what do the curves suggest as to the cost to our country of the USHA program if it is carried to its logical conclusion, if the 42 per cent of the population which seems eligible is all taken care of? We cannot approach this from the chart and we must remember that many different figures have been presented. Antagonists have by capitalizing current outlays reached astronomical figures; protagonists have in some cases made the activities of the USHA seem almost profitable.

Let us try to be a little more objective. Though the rents charged by the USHA are based, among other things, upon tax exemption, it is evident that the loss of revenue must be made up by some other revenue. Hence that loss of revenue is part of the cost of housing. For this reason, it is fair in the computation which follows to use the economic rent of 8.3 per cent. If we use this figure, the economic rent of a USHA shelter unit at $4800 will be $398 per year. From figures quoted in the USHA annual report, we find that the median, the modal, and the average rent in all projects come to the same figure of $15 per month[15] or $180 per year. Thus the median or average subsidy is $218 per family housed. This, bear in mind, is a figure in perpetuo, an *annual* charge on the nation so long as the program is pursued, because our economic rent is figured on a basis of self-perpetuation. Regardless of how the subsidy is originally furnished, the net result is an annual charge through a minimum of 60 years of $218 per family. Now if 42 per cent of our families are to be housed that way, that will mean 16,800,000 families. The product of that number of families by the annual subsidy is more than $3,500,000,000 per annum. Such amounts would have to be raised by taxation.

So far we have been working within rather rigid limits. We have been able to observe, given a fixed family-income pattern and a fixed cost for new shelter, what the effect is of altering the economic rent. The effect of altering the economic rent may be due to tax exemption, or lowering the rate of interest, or improving construction so that maintenance is lower, or to efficiency of management. One might construct any other curve of economic rent he wished. Thus this method would afford an opportunity for testing the effect of various rates of interest on the capacity of the population to enjoy housing of a given value. Since some people argue that interest is the real crux of the housing problem, it would be interesting to pursue their logic further; we have not time for that here.

REDUCING COST OF DWELLING UNIT

We should, however, make at least two other explorations. What happens, for example, if somehow we reduce the cost of the equivalent dwelling unit by 20 per cent? We need not try to determine how this reduction would take place. It might, for example, correspond to elimination of the value of land altogether, thus satisfying the cry of those who blame everything on the unearned increment. It might correspond to cutting the cost of construction by 25 per cent, thus satisfying the prefabricators. Evidently this, too, is a flexible factor which a student may move around to make his own studies and evidently interesting studies might also be made in this area.

The actual effect on our curves may well be tabulated alongside of the values when the cost of the unit is $4800. But first let us observe the effect on the subsidy area. With the new cost per unit the subsidy required, if the USHA were to keep the rents the same as now, would drop from $218 per family to $140 per family. Thus it would be possible either to

[15] Reference (11), p. 6, Table 2. The exact arithmetical median is $15.12; for purposes of this study $15 is sufficiently accurate.

reduce the total cost of subsidy per year by more than $1,000,000,000 or, by keeping the total subsidy the same, to increase the percentage of those housed. Employing a straight-line ratio, the new percentage of families taken care of by subsidy would be about 65 per cent. Applying this new 23 per cent, about half on either side of the subsidy area previously developed, the new values would appear:

	$4800 unit, per cent	$3850 unit, per cent
Hopeless	14	3
USHA subsidy	42	65
No man's land	36	19
Private	8	13
	100	100

This is evidently a substantial improvement.

There are interesting possible extensions of this study. Consider, for example, the impact of the $2000 unit which Mr. Davison has been advocating. More than 40 per cent of the population could occupy such shelter without subsidy at interest rates provided by private industry. Present rates of rent charged by the USHA would be more than economic for government-managed properties, financed for a long term at the rate of government bonds (i.e., $R = 8.3$ per cent). It would appear that almost the entire remaining 35 per cent could be housed with little cost more than tax exemption. The case is not quite so simple as that, but it is suggestive.

Finally, we must remember that these curves have been created for a period when family incomes were low. We have studied the general effect of altering the cost of the shelter unit, the financing charges, and taxes. Of the family income, two alterations are possible. The alternative of increasing the proportion of the family budget allotted to rent, the author does not care to consider here. You will observe that the result on the plot is identical with a corresponding decrease in the economic rent. But the case for changing incomes may be different. Let us therefore repeat our plot using the family-income distribution of 1929. For comparison, let us study the effect again on the $4800 shelter unit. It is a fair question whether family incomes can be restored without an increase in the cost of the shelter unit. To impose on this chart the additional reduction in the cost of the shelter unit may be too optimistic.

From Fig. 3 we can establish percentages as follows: On the basis of the $4800 unit: Hopeless, 0 per cent; USHA subsidy, 42 per cent; no man's land, 38 per cent; private, 20 per cent.

These figures perhaps cannot be treated with detailed respect. But they do hold forth hope that there is a solution for the housing problem. Collateral questions might arise, such as whether or not it would be a sound thing to have so large a per cent of our families on subsidy; as to whether, if that were to be the case, we had not set our shelter standards too high for our capacity to produce.

The approach which has been presented seems to have two interesting suggestions. Subject to revision of details, it seems to set forth a method by which rather sensitive studies may be made of the effect of any given economic factor on the housing problem. For our purposes, it is perhaps more important that it causes us to realize that no single change within any reasonable expectation can solve the problem alone. The charts show rather clearly that land can be reduced to zero as a capital charge and still this will not solve the problem; that interest rates can be brought essentially to nothing without solving the problem; that buildings can be amortized over precariously long periods without solving the problem; that the tax burden on real estate can be completely lifted without solving the problem; that terrifically large percentages of the population can have subsidized housing without solving the problem; that incomes can be restored to predepression levels without solving the problem; that costs of construction can be reduced to any reasonably conceivable figure without completely solving the problem, though having a great effect on its rigor.

But from this it is also possible to take encouragement, for with the working of all forces it becomes apparent that we may begin to approach a solution. The charts also demonstrate with some vigor that reductions in the cost of the shelter unit can have a rather tremendous effect upon the solution. They lead us to persevere in this realm of applied engineering.

EFFECT OF REDUCING INTEREST RATE OR BUILDING COST

Consider, for example, the implications of the following computations and justifiable interpolations. We shall seek to determine the probable effect of equivalent reductions in interest rate and construction cost. In each case, we shall keep all other factors constant and shall use as datum points the current values of $4800 for the cost of the new shelter unit and 4 per cent for the going rate of interest; we shall use uniform increments and decrements of 20 per cent of the preceding value.

If all other factors remain constant, a change in interest rate is reflected arithmetically by an identical change in the economic rent, R. Applying the various economic rents thus arrived at in Equation [1] with $s = 20$ per cent and $P = \$4800$, the income of a family which at that rate of interest can acquire the new shelter unit, is determined. The per cent of families thus able to afford such a unit can be obtained by straight-line interpolation in Table 2 (this introduces but a slight possible error). The incremental percentage can be calculated by subtraction and the final result expressed as a percentage of the preceding per cent of families.[16]

It is also possible by similar straight-line interpolation to determine the effect of 20 per cent changes from the basic cost of the shelter unit, keeping the economic rent constant at 12 per cent (4 per cent interest) and using $4800 for the basic unit cost. Here the different values of P are computed and the per cent of families affording are likewise computed from Table 2. Increments and per cent advantages are computed as in Table 4. This yields Table 5.

Tables 4 and 5 suggest with considerable vigor that far more is to be accomplished in helping the lower-income groups toward better housing at the present time through lowering the cost of the shelter unit than through tinkering with the interest rate. With different interest rates, different family-income distributions, and different basic unit costs, the results might be different but in the current situation the conclusion seems inescapable. The only alternative would seem to be a devastating subsidy.

They also suggest that there is a diminishing return in lowering the cost of construction but that this principle will not begin to operate with any force until the cost of the unit is below $2000, in other words, far below anything current techniques have been able to provide.

This matter has been dealt with at length, because it is highly important that we all realize the significance of reducing the cost of shelter construction. Moreover, the present state of development of new techniques for the production of shelter

[16] Specimen computation: A 20 per cent reduction of the 4 per cent interest rate yields an interest rate of 3.2 per cent. The economic rent is reduced from 12 per cent to 11.2 per cent. Setting this value of R in Equation [1] with $P = \$4800$ and $s = 20$ per cent, the value of family income is $2690. This income falls between $2500 and $3000 in Table 2. The increment of family percentages corresponding to this increment of income is 3.7. The straight-line interpolation is $190/500 \times 3.7$ or 1.4 per cent. Deducting this from the value at $2500 of 10.7 per cent, the per cent for an income of $2690 is 9.3 per cent. The corresponding interpolated per cent for the basic economic rent of 12 per cent (interest 4 per cent) is 7.9 per cent. The difference is 1.4 per cent and this is 18 per cent of 7.9 per cent.

TABLE 4[a] EFFECT OF 20 PER CENT INCREMENTS OF INTEREST RATE ON PERCENTAGE OF UNITED STATES FAMILIES (1935–1936 INCOMES) WHICH CAN AFFORD NEW SHELTER UNITS OF VALUE $4800 (BASIC INTEREST 4 PER CENT)

Interest, per cent	Interest increment, per cent	*R*, per cent	Family income	Families affording, per cent	Families increment, per cent	Advantage, per cent
8.4	20	16.4	$3940	3.7	—0.8	—18
7.0	20	15.0	3600	4.5	—1.1	—20
5.8	20	13.8	3310	5.6	—1.1	—16
4.8	20	12.8	3070	6.7	—1.2	—15
4.0 (datum)	..	12.0	2880	7.9	...	..
3.2	—20	11.2	2690	9.3	1.4	18
2.6	—20	10.6	2540	10.4	1.1	12
2.1	—20	10.1	2420	11.7	1.3	11
1.7	—20	9.7	2330	12.9	1.2	10

[a] Values in Tables 4 and 5 have been computed from Table 2. They are therefore considerably more accurate than readings from the charts would be. It is felt that the use of percentages to tenths is therefore warranted although these could not of course be checked from the charts nearer than the nearest whole per cent.

TABLE 5* EFFECT OF 20 PER CENT INCREMENTS IN COST OF SAME SHELTER UNIT ON PERCENTAGE OF UNITED STATES FAMILIES (1935–1936 INCOMES) WHICH CAN AFFORD NEW SHELTER UNIT OF THIS COST AT INTEREST RATE OF 4 PER CENT (*R* = 12 PER CENT; BASIC COST $4800)

P	Cost increment, per cent	Families affording, per cent	Family increment, per cent	Advantage, per cent
$9950	20	1.9	—0.4	—17
8290	20	2.3	—1.0	—33
6910	20	3.3	—1.7	—34
5760	20	5.0	—2.9	—37
4800 (datum)	..	7.9	..	..
3840	—20	13.2	5.3	67
3070	—20	21.9	8.7	66
2460	—20	32.2	10.3	47
1970	—20	44.2	12.0	37

* See footnote (*a*) Table 4.

is rudimentary; the scattering facts available are confusing and contradictory; there is insufficient evidence for the forming of any logical conclusions as to the possibilities; and, at this time, therefore, a paper on such possibilities would be purely speculative and a matter of personal opinion.

METHODS OF ATTEMPTING TO REDUCE CONSTRUCTION COSTS

The two general methods of attack on construction costs supplied by the construction industry or those interested in it have been:

1 By large-scale site developments, such as the recent Metropolitan Life Insurance Company housing project, where economies were sought fundamentally through mass buying power and large-scale efficient operation, or the Clairton project where new techniques were also employed.

2 By prefabrication or efforts to bring many field operations under the closer control and more consistent labor conditions of the factory.

The record of prefabrication is not one of success so far as the price to the consumer is concerned, at least not on any scale. On the other hand, two or three prefabricators have, it seems, been able to survive a very slow period of growth and may well go on now to success.

The records of large-scale operations are conflicting and not always clear. There are undoubtedly economies which are not swallowed up by the additional overheads. Just what things yield economies and what do not are not yet clearly known. There is need of close study of these operations by others than those who conduct them and dissemination of the facts concerning economies which may be effected by others who would follow in the pioneer's footsteps.

But large-scale operations are by their very essence confined to areas where a large number of similar units can be created at essentially the same time. They are admirably suited therefore to the project type of shelter unit which in turn seems best suited to the lowest-income groups. The biggest effect of close control of large-scale operations would therefore seem to be destined to fall in the subsidy groups.

On the other hand, prefabrication, if it is to succeed, must apparently rely principally upon the scattered house, on individualism if you like, and upon home ownership. The potential economies of prefabrication might also be added to those of large-scale operations on the site in certain cases. Thus in addition to the technical problems of production with which engineers are, undoubtedly, competent to cope, there are problems of distribution. It is in this field, in the author's judgment, that prefabrication has thus far proved least distinguished.

THE CASE FOR PREFABRICATION

What trends may in general be discerned?

1 There is some evidence that the prefabricators of today and those who are studying the possibility of entering the field of prefabrication tomorrow have seen the errors of the earlier days and are in large measure avoiding them now.[17]

2 To the author at least, it is abundantly clear, from statistical evidence based on population trends, on rates of house obsolescence, and other germane factors, that there is ample market for the prefabricator to permit the establishment of a genuinely large industry.

3 There is a trend at the moment toward the use of wood by the prefabricator. This is not necessarily a permanent trend. Wood has some obvious disadvantages for precision erection. But so far, these disadvantages have not outweighed its lower cost, particularly the much lower cost of machinery required to process it efficiently. This does not mean that wood can remain permanently in this strategic position.

That prefabrication can ever get over the economic hump between hand and machine manufacture is certainly not necessarily so. That it lies perpetually stymied is also not necessarily so. The techniques of construction and manufacture lie ready now for use and if, to the disadvantage of all of us, the hurdle is not surmounted the failure will not lie in the realm of technology.

* * * *

One further attack may be made upon reduction of construction costs without site development and without prefabrication. This would come as a result of greater coordination and integration of the building industry than now exists. Mr. Thurman Arnold's investigations may bear some fruit in this field. Efforts to organize building labor on different bases may have their effect. Voluntary coordinations also have promise. One of these has resulted at the moment in a study being carried on by the American Standards Association on standardized dimensions for building materials.[18] This study is perhaps as important a thing as is happening at the moment to warrant our close attention.

[17] "How Better Houses Will Be Built, the Question Mark of Prefabrication," by J. E. Burchard, paper presented at the M.I.T. Housing Conference, June 7, 1937; published in *The Technology Review*, July, 1937, p. 415, footnote (14), "Outline of reasons for past failures in prefabrication."

[18] Committee A62, Coordination of Dimensions of Building Materials and Equipment, sponsored by American Institute of Architects, Washington, D. C., and Producers' Council, Inc., New York, N. Y.

UNIONIZATION *of* ENGINEERS

One Man's Views Offered in the Hope of Stimulating Discussion

By JAMES H. HERRON

FELLOW OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

MANY engineers employed in industry may feel that they will advance their own interests by joining a labor union. Others may be drawn into a union by force of circumstances over which they have no control. There is evidence that considerable numbers have become members of labor organizations, particularly younger men and those rather vaguely designated as "technicians." The Federation of Architects, Engineers, Chemists, and Technicians claims to have made significant progress, and so do other organizations of the type. At least, enough engineers have become union members to force the leaders of certain important American engineering societies to recognize and discuss unionization as a serious problem in the profession, and conscientious younger engineers, and older engineers who have the interest of the younger men at heart, are seeking guidance in their attempts to understand the complex relations between unions and the engineering profession.

The perplexity of the younger men may be readily understood because even the wisest and oldest in the profession do not seem able to solve the problem. But certainly no solution can ever be had unless the problem is fully understood, and no full understanding of the problem seems possible without an inquiry into the growth of industry, and an examination of the traditions and ideals of unionism on the one hand and of the profession of engineering on the other.

DEVELOPMENT OF INDUSTRY

In the simpler life of mankind, activity was largely domestic and concerned the welfare of the family. The head of the family engaged in agriculture to win from the soil the essentials of bodily sustenance; he engaged in animal husbandry to procure food and clothing; and he defended his family against natural hazards and the aggression of covetous fellow men. In so far as these occupations demanded the special preparation of native materials to accomplish his purpose, each man was his own artisan.

But men were variously fitted for craftsmanship. It became apparent that the native aptitude of one person was lacking in another who excelled in some altogether different field of endeavor. And so came about division of labor. At first, the craftsman worked in his own home, or in the home of his patron. Eventually, the shop came into being; and as the demand for shopmade goods increased, the owner and operator could not himself execute all the work and hence he had to employ help. Labor therefore entered into industry in the role of a wage earner, and not as a participant in the hazards and the profits of the enterprise. Labor has held this position in industry ever since the distant past, and has always questioned what may be its rightful share in the positive financial returns which accrue to the business in which it is employed.

Prepared at the suggestion of the Committee on Economic Status of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS for the purpose of stimulating discussion of the subject. Comments are solicited. The opinions expressed are to be considered as those of the author, and not of the Committee or the Society.

The guilds represented an early phase of labor organization. They were fraternal societies whose members had to possess proficiency in the crafts represented by the guilds, and they exerted strong influences in the political and religious life of the Middle Ages, following the twelfth century in which they seem to have originated. Indeed, they still exist in the form of labor unions in European countries. These guilds controlled the entry of apprentices into the trades, set requirements for journeyman and master, and laid down regulations for the practices of the trades by residents and transients. Shop owners also organized trade or manufacturers' associations of a sort.

The guilds attained a strong economic position by cooperation and mutual agreement on policy because they were well organized, strong in membership, and opposed by only small and unorganized groups.

As the shop outgrew its original business structure, larger orders, increased labor requirements, greater stores of materials for process operations, longer time in manufacture, and prolonged delay in realizing on the outlay for labor and materials, taxed the financial resources of the owner. A new factor entered the industrial enterprise; capital was required from those who had resources and were willing to place them in the hands of trusted management for the sake of the anticipated earnings. Thus capital as well as labor became an important factor in industry.

With the continued development of industry and the social conditions it brought about, it became evident that there are three groups so vitally concerned with it that industry cannot exist independently of any one of them. These groups are: capital; represented by management and stockholders; labor; and the consuming public. Much conflict arises between two of the groups, capital and labor, and the third has become the "innocent bystander" who must "pay the freight" in the end.

The corporation, which replaced individual ownership when several investors organized to finance an industrial enterprise, lacked many of the familiar human attributes. Competition, the struggle for existence, and, in some cases, avidity, cupidity, and lust for economic and political power, caused certain corporations to use their great strength for ends not justified by the economic laws responsible for the institution of the corporations in the business world. As frequently happens, all corporations were charged with the abuses of the few, and at the turn of the present century it became a favorite sport of politicians, writers, cartoonists, and public speakers to represent the corporate entity in the form of a man, corpulent, hard-faced, greedy, ruthless, and stamped with the dollar sign to indicate the personification of wealth. A phrase was coined—"soulless as a corporation"—catchy to the popular mind more because of the sound than the sense it expressed.

To a degree, abuses resulted naturally enough from the new order of things. Stockholders of corporations expected their executives to produce results in the form of dividends

and paid them well when they succeeded in so doing. In their effort to justify their own employment and to enhance the value of investors' holdings, executives sometimes neglected certain phases of industrial operation, particularly employees' interests. On the other hand, many industries have made notable progress in recent years in their efforts to round into proper symmetry what was an unbalanced one-sided development.

This, then, in brief outline, is the story of the development of industry—the constantly changing scenery before which the engineering profession as well as labor unions have played their parts.

THE UNION IDEA AND GROWTH OF LABOR UNIONS

Labor has made sporadic attempts to organize in an effort to protect itself and what it conceives to be its rights against neglect and abuse. But the organization effort has been handicapped by the quality of its leadership and by lack of money. Labor leadership has come almost exclusively from the ranks and, on the whole, has been of inferior quality, although occasionally men of ability and commendable character have come to the front. Financial backing for the unions can be obtained only from those who profit from union activity, and since only the members can profit, resources have not been plentiful. Possession of wealth is likely to remove the possessor automatically from the laboring to the capitalist group. Consequently, only a small levy can ever be made upon the members of a union in the form of dues.

The Knights of Labor was the first really strong organization in the labor field in this country, and it reached the zenith of its power in the 1880's. Later the American Federation of Labor superseded the Knights of Labor, and more recently, the Congress of Industrial Organizations has achieved influence and prestige. At present, unionized labor is so strong that its demands cannot be ignored even if there were a disposition to give no heed to them.

Labor unions apparently feel no responsibility toward any groups but themselves. This may be legitimate in view of the avowed purposes of unions but it appears to be an exceedingly important matter in so far as the relation of labor unions to the engineering profession is concerned. While the method of collective bargaining or group action may be generally effective in increasing wages, can it stimulate individuality and the professional ideals which the engineer cherishes?

PROFESSIONAL AND UNION IDEALS

Engineers and labor unions, in my opinion, have so little in common that unionization of engineers is at least an unnatural development.

The typical union is concerned exclusively with the economic well-being of its members, and with the public welfare only in so far as the union members may be able to take advantage of that welfare. Is this a suitable and proper attitude for a profession? Let us examine the purposes of one union of "engineers."

The most important union which has grown up in engineering types of employment is the Federation of Architects, Engineers, Chemists, and Technicians, affiliated with the C.I.O. The aims and viewpoints of this organization appear to be quite in accord with familiar labor-union purposes and ideals. According to a report of an annual meeting of the Federation which appeared in the *Architectural Forum* for November, 1933, the Federation supported the following program:

1 Thirty hours of work per week.

2 Only "extreme emergency" overtime, to be paid for at double-time rate.

3 Minimum-wage scale of $65 per week for senior technicians, $45 for juniors, $35 for assistants, and $30 for apprentices.

4 A voice in the administration of the (NRA) code.

This is familiar language, the unusual plea from any typical labor organization, necessary, no doubt, and proper in a union, but is it appropriate as the primary objective of a professional group? The engineer should think of service as his principal concern. His salary depends upon the services he renders; service first, then salary. If the idea of compensation is constantly intruding itself upon his thought, he is likely to accomplish little in the way of constructive work. "A worker is worthy of his hire," but the engineer must keep this thought in the background or it will "cramp" his professional style, although it is conceded, of course, that a serious deficiency in income will not expand his professional style either. The aim of the profession should be primarily one of service, i.e., service for the common good. This aim may be accomplished through an employer, or by direct contact, but the final aim remains the same.

Obviously, not all engineers live up to this professional ideal but they should; and in any case, the fact that some do not is no proof that labor-union ideals and professional ideals can be made to harmonize.

In the *Architectural Record* for January, 1939, it is reported concerning the meeting of the Federation of Architects, Engineers, Chemists, and Technicians held at Washington in December, that "the international officers of F.A.E.C.T. (C.I.O.) were all unanimously elected, an action which disclosed, they said, the unanimity of the entire membership, and complete devotion to the principles of the C.I.O. and the complete unity within that labor body."

No matter how sympathetic one may be toward the efforts of the C.I.O. to improve the lot of the working man, it seems to be quite impossible to discover in the official statements of C.I.O. leaders, or more particularly, in the actions of the C.I.O. unions, any serious concern for the public welfare, or at least not that type of concern for the public welfare in preference to personal and group welfare which should be characteristic of any vocation which pretends to be a profession. It seems open to question whether any organization of engineers which is affiliated with a labor union of this type will be able to maintain the high standards required of a profession. The engineer is thoughtful and conservative and shuns anything of a superficial character. The engineer is also characterized by a desire to abide by a code of ethics which governs his relations to his employer and to his fellow engineers, and he is at odds with any group which does not have a similar code.

The highest ideals of the engineering profession were forcefully expressed by Dr. Vannevar Bush, president of the Carnegie Institution and formerly vice-president and dean of the Massachusetts Institute of Technology, in his address before the meeting of the American Engineering Council in January, 1939. He spoke of "the heights of true professional attainment, where honor and individual recognition by fellows is the real reward, and where the watchword is that old, old theme, which has never lost its power, and which may yet save a sorry world, simple ministration to the people."

Such a statement surely stirs pride and loyalty to the profession in any truly professional engineer. Would it be acclaimed in a national meeting of an engineers' union? Perhaps, but I have my doubts.

Of course, all this has nothing to do with the just compensation of engineers. Many engineers doubtless receive less than they earn. But this is not the issue. The question is whether

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EXTRA-TARIFF CONTROL *of* FOREIGN TRADE

By FLOYD E. ARMSTRONG

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A SIGNIFICANT and not generally recognized development has been quietly taking place during recent years—a development that may well be the decisive step in remaking our national economy along lines of authoritative control. It is the astonishing growth of the power and influence of administrative boards. These boards, that have been created and put into operation, exist in many different areas. Persons engaged in the fields of banking, railroads, public utilities, investment banking, brokerage, and many aspects of manufacturing and merchandising find themselves subjected not only to the restraint or command of regularly enacted statutes, but to pronouncements no less authoritative that are mere edicts of these administrative bodies. Their orders have the force of law—in fact are law. Through the exercise of broad delegated powers, these boards have come to be, within their respective areas, true law-making authorities.

Apparently, the earlier narrow interpretation of the constitutional limitation on the right of Congress to delegate its legislative power is undergoing a very great change. An examination of the causes that have led to this change and the emergence of these extra-congressional legislative bodies is beyond the scope of this article, but it is important to note that their appearance has not been sudden or abrupt. They have been coming by slow degrees since the establishment of the Interstate Commerce Commission in 1887. At first they have usually possessed only investigatory privileges but later they have come to exercise positive control over business operations. Their recent rapid growth in numbers and in power is probably the result not so much of legislative incompetence and executive aggressiveness (though each of these circumstances has been present) as to the absolute inadequacy of any law or set of laws to cope with the complex and rapidly changing problems of our modern economic life.

ADMINISTRATION CONTROL IN FIELD OF FOREIGN TRADE

Perhaps the least understood and most generally unrecognized area of administrative control is in the field of foreign trade. To an astonishing degree the importer is subjected to administrative regulations and legislative decrees that govern his operations and curb imports even more than regularly enacted and published tariffs. At the same time many delicate questions of international relationships may be affected by the policies pursued by such bodies as approved by the Executive. A case in point was the announcement by Mr. Morgenthau, Secretary of the Treasury, on March 19, 1939, that there had been added to existing import duties on German goods an additional or countervailing duty equal to 25 per cent of their value. Of course the executive branch of government was fully empowered by general Congressional enactment to take such a step, but it was in fact specific tariff legislation outside of Congress and was generally interpreted as a gesture by the Administration to show its disapproval of the policies being pursued by Germany in Central Europe. It is not difficult to perceive embarrassing international situations arising from an injudicious use of such powers. The development and operation of this system of tariff controls has been comprehensively portrayed in a book just published entitled, "The Invisible Tariff.[1]"

The Tariff Act of 1930, as amended in 1938, embodies the principal provisions that have made possible the extension of authority here considered, although customs regulations, regulations of bureaus and divisions in the Department of Agriculture and the Bureau of Narcotics have all contributed to the growth of extra-tariff control of imports. The specific influences that have stimulated the expanding exercise and use of the authority under discussion are to be found in our traditional policy of protectionism against foreign trade competitors and the increasing use of the police power to regulate and control commerce. With the growth of authoritarian governments abroad and their unorthodox methods of trade, resort has been had to the extra-tariff powers of the executive department as a means of combating the unbearably aggressive trade practices of such governments.

Some of the places where the exercise of the controls that are being considered have appeared are as follows: First, in the administration of the customs. Even though tariff laws contain very precise and definite terms relating to importation of goods and the duties to be paid, it is obvious that customs officials, in the interpretation and application of such laws, may exercise powers and make arbitrary rulings that alter or amend or even nullify the intent and purpose of the enactments. Through valuation, changes in rates (without adequate publicity) and classification of imports for dutiable purpose, indifferent or designing customs officials may in effect legislate arbitrarily on tariff matters. Even though appeal be taken to a Customs Court, there is small likelihood that the decisions of the customs officials will be reversed. In 1937–1938 of the cases appealed on the issue of classification 89 per cent were won by the government as were 81 per cent of the cases appealed on the issue of appraisal. A second important area where extra-tariff controls have been exercised is in the application of laws for the protection of American business against unfair competition from abroad. Such laws operate in the first place against our own domestic manufacturers but they apply also of course to those engaged in foreign trade. In carrying out the tariff acts as they bear on this point, officials must interpret the statutes as to (1) the identification of foreign goods by "marks of origin," (2) anti-dumping clauses, (3) countervailing duties against bounty-fed imports, and (4) clauses penalizing imports from countries that discriminate against American commerce.

MEASURE OF LEGISLATIVE DISCRETION

A mere glance at the foregoing will indicate to a thoughtful observer the measure of legislative discretion that must be

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[1] "The Invisible Tariff," by Percy W. Bidwell, Council on Foreign Relations, New York, 1939, 286 pp.

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MODERN TIMBER CONSTRUCTION

Timber as a Structural Material and Devices for Joining Timbers

By C. PANTKE

ROOF STRUCTURES, INCORPORATED, NEW YORK, N. Y.

TIMBER, once a cherished structural material, was relegated to the position of a stepchild when steel and reinforced concrete made their appearance. Consequently, its development has been retarded while the others made such spectacular progress. Yet it remains a useful, though in many respects, capricious, structural material. Being produced by nature on its own terms without the benefit of an engineer's advice, it comes to us as a nonhomogeneous and nonuniform material. Since its strength and its very dimensions are sensitive to various influences, its intelligent use requires considerable theoretical understanding and practical experience. Consequently, an engineer who deals with timber only occasionally may easily expect from it too much or too little. Expecting too much may cause disappointment and expecting too little may lead to the dismissal of timber, our only renewable source of structural material, where it would prove the best servant.

TIMBER AS A STRUCTURAL MATERIAL

Although for many years timber did not share in the technical attention given to other structural materials, during the last 25 years it has become the object of considerable research and experimentation. Great progress has been made in determining its peculiarities and in predicting correctly what it will do and what it will not do over a great length of time and under a great variety of conditions. This information enables us commercially to diagnose the stock today and assign only the healthiest and toughest specimens to structural uses. These we can disinfect and immunize to meet the requirements of their designated purposes. Furthermore we have at our disposal mechanical and chemical methods of molding laminations of timber into structural shapes more efficient than the original circular or rectangular ones. Finally, we can form them to any required curves and can economically connect them into rigid structures of dependable and permanent strength. Of course, timber has limitations as has any other material, but as research and experience have more clearly established some of them, so they have overcome others and opened up an abundance of new applications. As yet, too little of the available technical information on timber construction is generally known by the members of our profession. It is hoped that this paper will prove a contribution toward more widely diffusing at least part of this new knowledge among engineers.

The new interest in timber construction originated in European countries as the result of a scarcity of the raw materials required for the manufacture of steel and concrete. This scarcity, which became especially acute during and after the great war, directed the thoughts of engineers and builders toward making better use of the available domestic timber stocks. In this country the revival came later and not for the same reasons. The driving force here was by no means a shortage of raw materials but rather the wealth of excellent timber stocks and the demand by builders for a structural material still more economical and more adaptable to certain immediate needs than steel and reinforced concrete. An added factor was the comparatively recent realization that timber of more than a specified minimum size resists fire better than exposed steel and commands consequently a lower insurance rate.

Presented at the twelfth national meeting, Boston, Mass., Oct. 12–13, 1939, of the Wood Industries Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

REVIVAL OF TIMBER CONSTRUCTION IN UNITED STATES

The revival of timber construction in this country dates back to 1925. It is true that timber was used for some structural purposes before that time by railroads, dockbuilders, and a few commercial organizations that manufactured special—often patented—types of construction. But there was no uniform practice founded on authoritative research and common experience. The only firm basis available to a timber designer were data on the strength of small, clear specimens of American timber. These data were based on approximately 130,000 tests made by the U. S. Forest Products Laboratory in Madison, Wis., and reported by J. A. Newlin and T. R. C. Wilson. They were extremely valuable and indispensable as a foundation for future research and standards, but small, clear specimens of timber are not used in construction. Whatever other research work had been done was scattered and the results had either not been published or were not generally accepted. The designer, therefore, had to rely on his own judgment in writing the specification for the material and in assigning safe working stresses. The same held true for the connective devices of which at that time only nails, screws, and bolts were known. As a consequence there were such instances as the building code of New York City which permitted for Douglas fir a tension value of 800 psi, while St. Louis would permit for the identical piece of timber twice that stress. On the other hand the permissible compression across the grain would in some cities be limited to 300 psi, while New York City permitted 1000 psi. No building code ventured to specify strength values for connective devices, and recommendations by individual authorities varied as much as 100 per cent. Unfortunately, the memory of this state of affairs lingers still in the minds of many American engineers, while they are not aware of the creditable research work done during the last 14 years, principally by the U. S. Forest Products Laboratory.

The new impetus was given in 1925 by the Secretary of Commerce, Herbert Hoover, when he established the National Committee on Wood Utilization and secured for it the cooperation of the Forest Products Laboratory which is maintained by the U. S. Department of Agriculture in cooperation with the University of Wisconsin. Both the committee and the laboratory, with the assistance of the National Lumber Manufacturers Association, have in 14 years established a body of unified knowledge and standards which enables the timber engineer today to design with a facility, latitude, and assurance comparable to that of the steel and reinforced-concrete engineer.

The first step was two studies by the Forest Products Laboratory, both published in 1930. The one by L. J. Markwardt dealt with the comparative strength properties of United States timbers. It established definite working stresses for the

commercial structural grades of American species. The other, by J. A. Newlin and J. M. Gahagan, reported an extensive series of tests of large timber columns and presented to the American timber designer a dependable column formula. Both studies are generally accepted today and form the basis of all modern building codes.

Another urgent need was filled when G. W. Trayer of the Forest Products Laboratory reported in 1932 on the bearing strength of American timbers under bolts. The working stresses and design practices recommended in this bulletin are based on a large number of tests, some of them under loads repeated more than a hundred times, so that previous uncertainties are definitely eliminated. A similar study was made later on the strength of nails, drift bolts, and screws.

It was fortunate that to the directorship of the National Committee on Wood Utilization was appointed an engineer who was familiar with the progress made previously in Europe. Axel H. Oxholm had come in contact with the European developments during the war, and he made an extensive survey of them. He brought back 60 different mechanical connecting devices capable of assuming in timber construction the same function as rivets in steel construction. The most promising types were tested and safe working loads were assigned to them by the Forest Products Laboratory. The results were reported in 1933 by Nelson S. Perkins, Peter Landsem, and G. W. Trayer. When in 1934 the committee was dissolved, a great part of its functions were taken over by the Timber Engineering Co. of Washington, D. C., a subsidiary of the National Lumber Manufacturers Association. Today this firm has acquired the patent rights on these connectors for the purpose of promoting the use of lumber and distributes them on a commercial basis making them available to the entire lumber and construction industry.

Mr. Oxholm also reported many new possibilities opened up by the use of chemical adhesives. Their value in timber construction is comparable to that of welding in steel construction. They make it possible to build up from laminations structural members either straight or curved and in shapes similar to those found so efficient and economical in steel construction. They also permit the manufacture of structural gusset plates and of beam sizes larger and more uniform than nature has been willing to produce. While chemical adhesives had been used in this country for a long time previously, particularly in the plywood and airplane manufacture, their application to timber structures had been confined to only one commercial firm and had remained essentially unknown. The available scattered information about glues and their effect on American timbers was first collected and reviewed by T. R. Truax of the Forest Products Laboratory. A comprehensive series of tests was made and the results were published in 1929.

At that time the laboratory took up a study of the strength and durability of full-size structural members built up with the aid of these glues. In 1935 it used this type of construction for two of its own buildings and loaded one unit with about one and one-half times the design load. The load was left in place and measurements were taken over a period of about six months. Other structural members were tested for periods of about two and one-half years. Such long-time loading tests are of importance in timber construction because the duration-of-loading effect is more pronounced than in steel or reinforced-concrete construction. This incidentally is caused by the same quality which makes timber superior to other structural materials in regard to impact resistance. This research project, which was conducted and reported by T. R. C. Wilson, is being prepared for publication.

European laboratories had also perfected improved adhesives in the form of synthetic resins. These were of immediate interest to the plywood industry, because they are definitely waterproof, while all previously used glues could be termed only water-resistant. They were first imported but are now manufactured in this country in various forms and are extensively used by a great number of woodworking plants. Several papers covering this phase have been presented to this Society in the past.

The plywoods are of importance in timber construction because they make it possible to premanufacture structural panels with stressed coverings similar to the battleship decks in steel construction. Such a panel consists of one plywood sheet on top and one on bottom, separated by timber joists. The whole is nailed and glued to form a boxed beam about four feet wide by sixteen feet long. The plywood sheets form the flanges and the joists the webs. The panels have a strength and rigidity about three times as great as that of the joists alone. They are easily handled and save a large amount of erection labor.

Plywood also serves a useful purpose as webs for girders and as gusset plates for trusses. Generally, it is possible to avoid gusset plates in timber construction because the members are fairly wide and not sensitive to eccentric connections. In fact, the skill of a timber engineer consists largely in laying out his structure in such a manner that gusset plates are not needed. Where he cannot get along without them, he uses steel plates. These are expensive, difficult to fit, and not adapted to the timber's tendency to shrink when seasoning. Plywood gusset plates will be a great improvement and will give the timber engineer greater latitude in design. After some research they have already been used successfully in several recent structures. However, at present in the East, they are not available from local stock. Their evolution is probably not completed.

This brings us to the state of timber construction at the present time. Earnest research work has brought into existence several commercial firms in the West, Middle West, and East, specializing in timber construction and taking active part in its further perfection. They have many interesting installations to their credit, but of greater importance is the growing interest taken by architects and engineers during recent years. They are beginning to recognize the merits of timber and some of them in their various spheres of interest are recommending and using wood in its proper place.

PRESERVATIVE TREATMENTS FOR TIMBER

This picture would not be complete without mentioning that creditable progress has also been made in preservative treatments. There is a suitable preservative available for about every reasonable hazard. Timber structures so treated will greatly outlast galvanized steel under many conditions. Under others they will have the same life expectancy, and where their estimated life is less, economy is often still on the side of timber. Experience indicates that most timber structures in this country outlast their usefulness, and that premature replacements due to decay or attack are necessary only as a consequence of some serious error in planning or omission in protection. Many untreated timber structures in Europe have served several hundred years without being considered unsafe. For instance, an untreated boathouse in London built in 1400 lasted until 1921. It was torn down because its chimney had collapsed.

Although much is heard about the destructive activities of termites in this country the actual damage is in general small. Dr. Thomas E. Snyder and his collaborators of the U. S. Bureau of Entomology have made a valuable contribution in dispelling these fears through revealing the life habits of termites and recommending simple and inexpensive preventives or remedies. It is sufficient to say that where termite shields have been installed there is no known case of damage to the structure.

Unfortunately, it must be stated that no economical or even practical method is yet available to make structural timbers fireproof. Certain impregnations, however, will render them incapable of supporting combustion. It is also claimed that certain paints have a fire-retarding action, but no generally accepted standards have been developed. The best protection of timber construction against fire is the avoidance of small sizes. A minimum size of 4 × 4 will give about the same fire resistance as unprotected steel, while larger sizes with chamfered corners will be superior to it. The fact that timber burns while steel and reinforced concrete do not has been exploited beyond reason as an argument against timber as a structural material. It may seem surprising, but during fire tests conducted in July of this year in Washington, D. C., by the U. S. Bureau of Standards, the so-called fireproof steel framework of an old two-story building which was supposed to have a fire resistance of about five hours collapsed in one hour and fourteen minutes, that is, in one fourth of the rated time. This seems to indicate that the fire resistance of widely praised incombustible structural materials is sometimes overrated. On the other hand we all have heard a great deal of criticism of the New York City Tenement Law which was put in force in 1900 and permitted wood joists, wood-stud partitions, and wood lath in tenements up to six stories or 75 ft in height. Probably all of us have at times been under the impression that many human lives must have been lost in such so-called fire traps. It is therefore still more surprising to read in a report, issued in 1930 by a subcommittee on fire statistics, Multiple Dwelling Law, the following statement (Bureau of Fatality Statistics of the State of New York Tenement House Department):

> The record of deaths by fires in tenement houses includes deaths from all causes such as individual accidents, children playing with matches, re-entering or remaining in building to obtain possessions, paralysis from fright, and other causes. *There has never been a life lost by fire in a New York tenement due to conflagration of the building or to any defect in the construction or arrangement of same.*

This seems to indicate that the record of a widely denounced type of construction has been rather good for a period of at least thirty years.

The fire hazard presented by a given building is not determined solely by the combustible or incombustible character of the building material. The afore-mentioned fire tests at Washington proved again that it is far more the contents than the structure itself that originate and feed the fire. Other factors to be considered are protection with sprinkler systems, efficiency and availability of fire departments, accessibility of the building, and water supply. All this is recognized by insurance underwriters who, for instance, have assigned to mill-type timber construction protected by automatic sprinklers insurance rates which compare well with those of fireproof structures. This is not to minimize the merits of other structural materials but merely to indicate that timber is suitable for more types of buildings than is generally admitted today. A pertinent example of this is the airplane hangar. It usually stands isolated, and therefore the danger to other buildings is small even if the entire structure should burn down. On the other hand the contents of a hangar are highly inflammable and develop a fire of short duration but of enormous heat. This is just the type for which unprotected steel is unsuitable. If the hangar consists of brick walls with unprotected steel trusses, the latter will expand, damage the walls, and soon collapse without warning from loss of strength with the rise in temperature. Timber trusses on the other hand will not endanger the walls and are less affected by the intensity of the fire than by its duration because their strength diminishes only in proportion to the loss of cross section with the charred surface acting as an insulator. If the fire does not last long, they have a good chance to weather it. In the case of a collapse, they give ample warning and their removal is much less costly than the untangling of a collapsed steel structure. Whatever additional fuel the timbers furnish to the fire is immaterial compared to the contents of the hangar.

DEVICES FOR JOINING TIMBERS

NAILS, SCREWS, DRIFT BOLTS, AND BOLTS

The oldest mechanical devices used for shear connections in timber were wooden pins or dowels, succeeded by nails and bolts. The major distinction is that nails are inserted with considerable force and rely for proper action on friction, whereas bolts are installed more or less loosely into prebored holes, with friction playing no important part. Therefore screws and drift bolts, which depend on friction, fall into the same classification as nails.

The function of nails, screws, and drift bolts is the same as that of rivets in steel construction; however they have a disadvantage in that their ratio of slenderness is very high. For instance, whereas a $^3/_4$-in-diameter rivet is associated with an average plate thickness of $^3/_8$ in., a $^7/_{16}$-in-diameter drift bolt may be used for a timber $3^1/_2$ in. thick. In other words, while the ratio of plate thickness to rivet diameter is of an average magnitude of $^1/_2$ the equivalent value for timbers and drift bolts may be 8. For nails it may be as much as 12. This means that nails and drift bolts are subject not only to shear but also to bending, which causes a nonuniform bearing pressure.

This condition together with the effects of shrinkage and checking has defied any purely theoretical attack, and all safe working loads have therefore been established by a large number of tests. Detailed reports may be found in the literature cited later on and are therefore not repeated here. It may be mentioned, however, that the recommended safe values are based on the proportional-limit load of the connection and an appropriate safety factor.

Nails are ordinarily not accepted in this country for primary load-carrying connections. They are distrusted because the art of using them safely is little known and not well established in practice. Other countries, however, have been persuaded by economical considerations to investigate, and they have established a set of rules under which the nail becomes a safe connector. For instance, the lumber should be seasoned approximately to the moisture content under which it will eventually remain. To avoid splitting of the timbers, the nails should have a diameter of not more than one seventh of the thickness of the timber, and they must be arranged in a predetermined pattern so that the gage lines form an angle of about 1:10 with the wood fibers. Also the length, spacing, and distances of the nails from the edges and ends of the timbers are regulated. The results are reported to be satisfactory. Nailed girders have been tested in Europe under loads repeated up to 20,000 times, and nailed trusses have been used for spans up to 82 ft on 13-ft spacing.

Most engineers are not aware that thousands of buildings in this country have roof trusses of spans up to 120 ft, the strength of which depends essentially on nails. These trusses are known as latticed trusses and have been built since about 1910, especially in Chicago and New York City. Their timbers were not seasoned, and only moderate attention was paid to the spacing or the pattern of the nails, but they have very probably a higher factor of safety than a correctly designed steel truss. The author had occasion to test one 88-ft truss that had been in service for about 10 years. A load of 170,000 lb, equivalent to about twice the design live load, was applied and the deflec-

tion was only $^1/_{350}$ of the span. Judging from indications, the truss would have carried more than three times the design load, which is better than could reasonably be expected from a properly designed steel truss. Of course the factor of safety for steel structures[1] is not 4 but little higher than 2.

Nails have the advantage in that they form with the timber an intimate contact of comparatively large surface area and distribute the forces uniformly over the entire joint. For instance, 32 twenty-penny nails weigh not more than one $^3/_4$-in. bolt, but they will form a more rigid and stronger connection. Of course, the fact that nails must be driven by hand and the requirement that they must have a length of at least twice the thickness of the timber form a limitation. The largest nail (60d) is only 6 in. long and therefore suitable for a timber only $2^3/_4$ in. thick.

To maintain the advantages of nails for several layers of thin timbers, it is possible to use $^5/_{16}$ to $^7/_{16}$-in. drift bolts which are inserted into prebored holes of slightly smaller diameter. They are preferably made of high-strength steel and driven with pneumatic or electric hammers. Connections of this type are indeed very rigid. The diagonal shown in Fig. 1 carried 36,000 lb (2.6 times the design load) without failure. This is 2250 lb for each of the 16 drift bolts of $^5/_{16}$-in. diameter. Even the drift bolts, however, are practical only for timbers up to a maximum thickness of $3^1/_2$ in. and their diameter will then be about $^7/_{16}$ in. Almost any structure will require at least three thicknesses, and if each is $3^1/_2$ in., this makes the dowels $10^1/_2$ in. long, not considering the greater thickness at the splices. The driving then becomes difficult, and great care must be exercised that the timbers do not split. Hence this is a point where the use of bolts, which do not require force for insertion, is more practical.

Of all connective devices for timbers, bolts have had the widest appeal. As a rule they are inserted into holes $^1/_{16}$ in. larger than their own diameter. This increases the natural initial yield of timber structures by about $^1/_{32}$ in. for every connection, and therefore a structure with many bolted connections has a greater unelastic deflection than a nailed or drift-bolted structure. For this reason the timber designer always provides his bolted structures with ample cambers and limits the number of joints and splices to a minimum.

The most popular bolted structure in this country is probably the so-called bowstring truss. The author tested one 75-ft span and one 100-ft span with 120,000 lb and 174,000 lb, respectively,

[1] "The Structural Significance of Stress," by Bruce Johnston, *Civil Engineering*, May, 1939, p. 291.

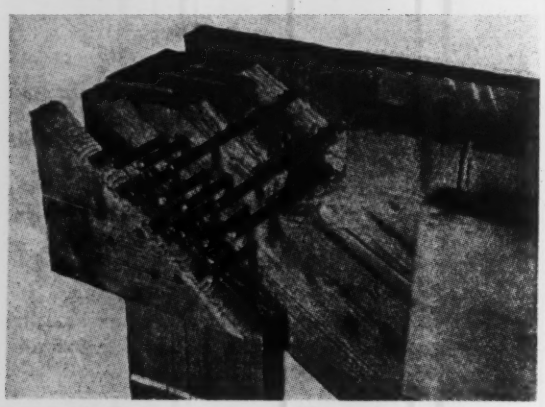

FIG. 1 JOINT WITH 16 DRIFT BOLTS $^5/_{16}$ IN. DIAMETER OPENED FOR INSPECTION AFTER LOADING

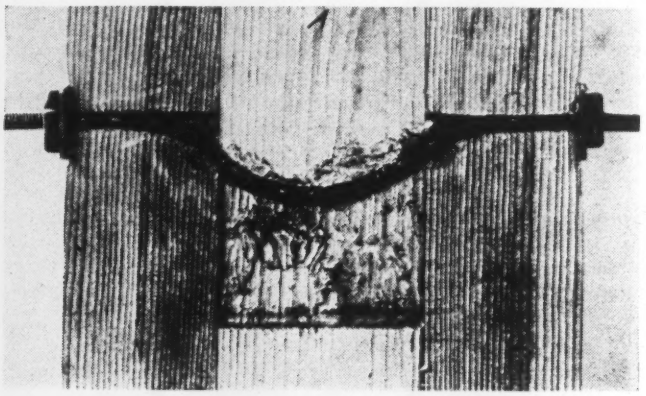

FIG. 2 DEFORMATION OF A SLENDER BOLT IN A TIMBER JOINT AT ULTIMATE LOAD

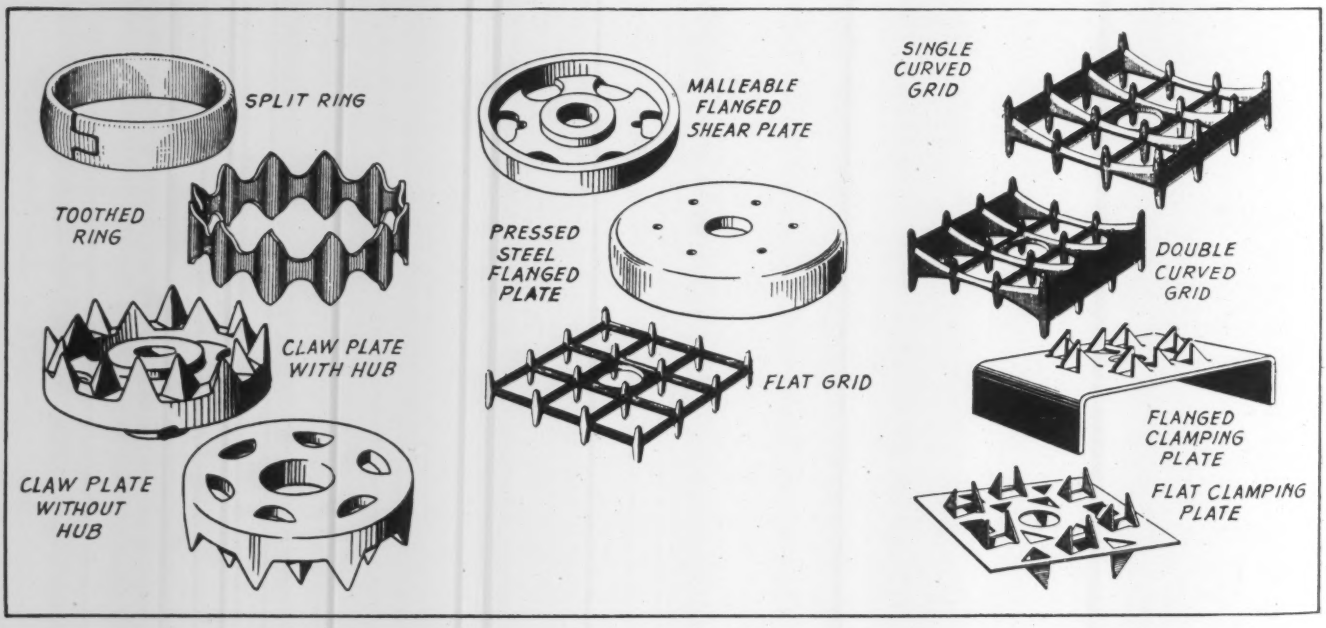

FIG. 3 MODERN CONNECTORS FOR TIMBER JOINTS

which were twice the design live loads. The trusses suffered no damage under this load and deflected only $^1/_{168}$ and $^1/_{211}$ of the span. It will be noted, however, that these values are about twice the deflection of the nailed latticed truss previously mentioned. After removal of the loads in both cases, the trusses regained more than one half of the total deflection; the remainder represented the unelastic yield of the structure.

As mentioned before, nails, screws, and drift bolts are stressed not only in shear but also in bending. This is true again for bolts. It will be observed from Fig. 2 that because flexure is present the actual bearing is distributed over a comparatively small part of the length of the bolt, and even within this part the full bearing strength of the timber is utilized only at one point. Evidently, the bolt would not carry more even if the timbers were thicker. In fact, its diameter D is already too small compared to the thickness of the center timber L. The ratio L/D in this case happens to be 14, whereas the bearing capacity of the bolt would be exhausted at a ratio of 6 or 7. In other words, in bearing parallel with the grain, a 1-in. bolt reaches its maximum safe load in a 6-in. timber and cannot be credited with more load in an 8- or 10-in. timber. For the same reason the strength of a $^3/_{16}$-in. nail will be fully exploited in a plank thickness L of seven times this diameter D, or $1^5/_{16}$ in. Inasmuch as nails—to avoid splitting of the timber—must never have an L/D ratio of less than 7, they are rated at their maximum safe load. Bolts, on the other hand, should preferably be designed with a bearing length smaller than the critical one, and their safe load will therefore vary with the L/D ratio.

The same situation prevails in bearing perpendicular to the fiber of the timbers with the exception that an increase of L/D beyond 8 actually decreases the proportional-limit load of the connective device (though only slightly). In other words the safe load of a 1-in. bolt is somewhat higher in an 8-in. timber than in a 10-in. timber. There is also this difference, that the proportional limit of the bearing stress across grain increases as D decreases. For instance, the safe load of a $^5/_8$-in. bolt in a $2^1/_2$-in. timber is 1500 lb parallel to the fiber but only 650 lb perpendicular to it, while for a $^5/_{16}$-in. bolt it is in both cases 415 lb. Four $^5/_{16}$-in. bolts weigh the same as one $^5/_8$-in. bolt, but they will carry in any direction 1660 lb. This explains the relative efficiency of nails and drift bolts within their limitations. It demonstrates, on the other hand why, beyond these limitations, the timber designer was handicapped by want of connective devices more efficient than bolts.

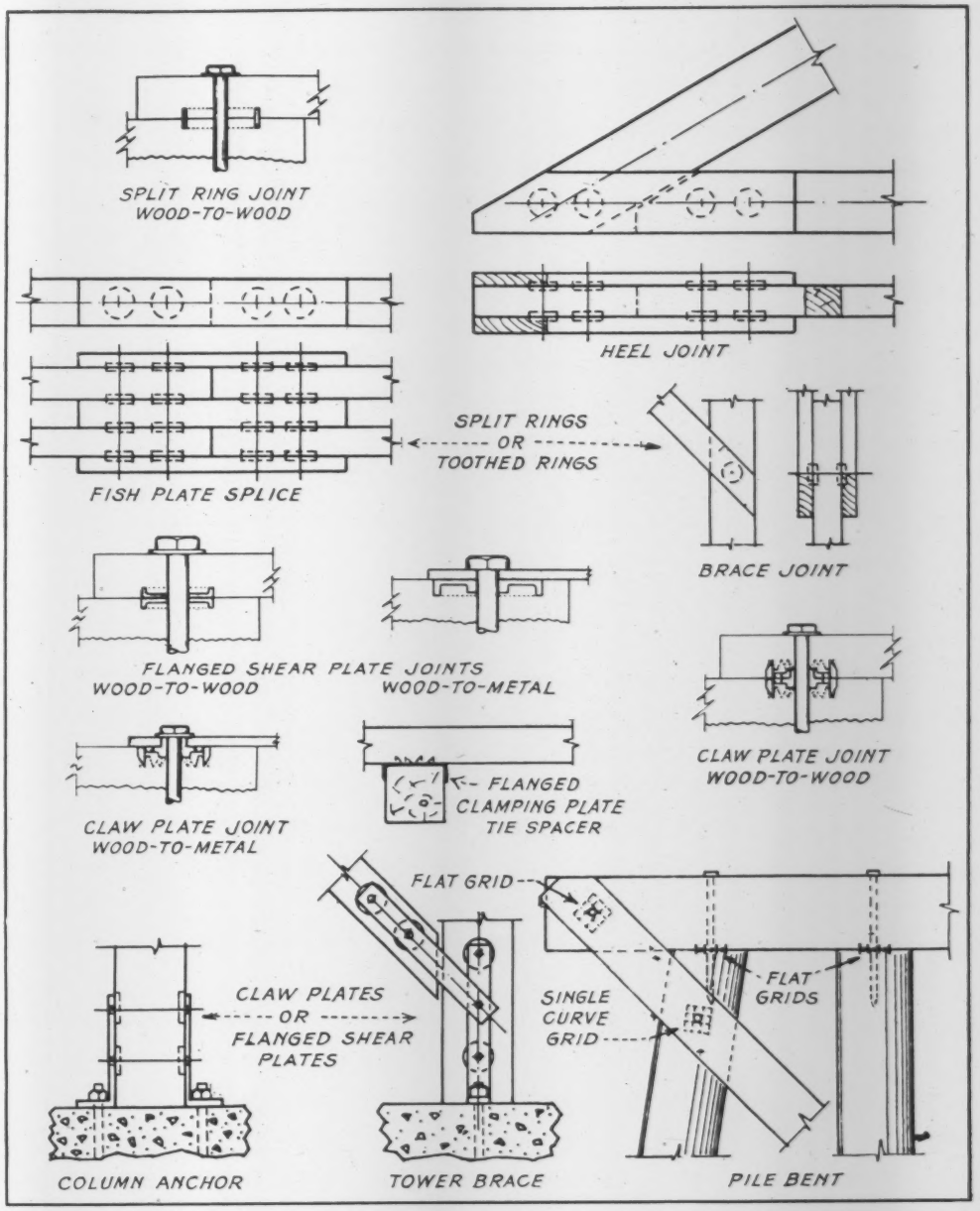

FIG. 4 TYPICAL CONNECTOR JOINTS

MODERN CONNECTORS

This situation was remedied by the introduction of the so-called modern connectors (Figs. 3 and 4). It will be noted that they bear only on part of the thickness of the timber, but distribute the bearing over a greater width than bolts. This eliminates the bending and consequently reduces the possible deformation. They can again be classified into two groups: (1) Those that are pressed into the timbers by application of force, as toothed rings, grids, and clamping plates; and (2) those that are inserted into precut grooves such as split rings, shear plates, and claw plates. The first group serves exclusively for connections of timber to timber, while the second group includes devices suitable for connections of steel to timbers (shear plates and claw plates).

Of course, the connectors do not hold the timbers in position,

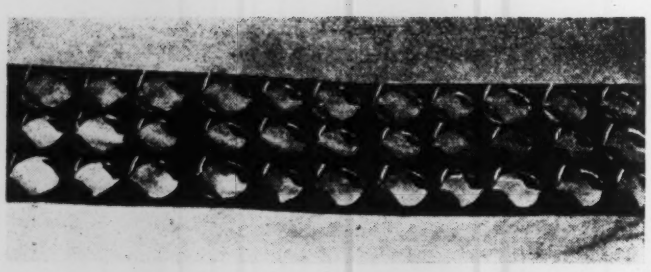

FIG. 5 TOOTHED RIBBON CONNECTOR

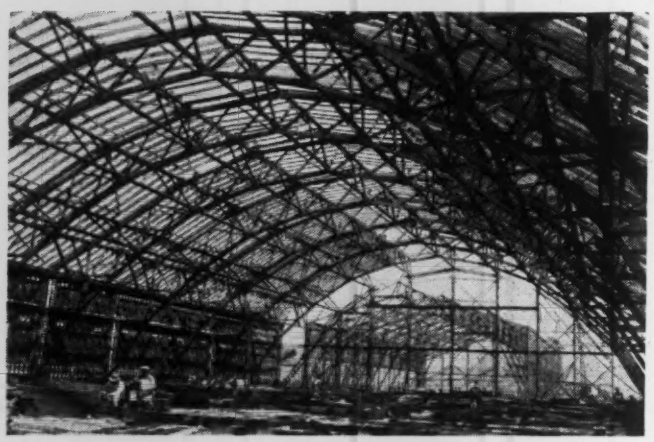

FIG. 6 TIMBER ARCHES OF 200 FT SPAN FOR A STRUCTURE TO BE ENCLOSED BY MEANS OF PREFABRICATED ROOF AND WALL PANELS

FIG. 7 104 FT COLUMN FOR GOLDEN GATE INTERNATIONAL EXPOSITION, SAN FRANCISCO, CALIF.

they merely resist the shear between them. Therefore, they can be used only in combination with bolts. The latter, however, may be of small diameter. The pressure required for connectors of group 1 is usually applied with a few special high-strength bolts acting on ball-bearing washers. Afterward, ordinary bolts are inserted. This process is somewhat cumbersome, and care must be taken that the teeth of the connectors do not split the timbers, if thin. The thought therefore comes to mind whether for some purposes it may not be useful to keep the teeth still smaller but increase their number. Indeed, such a connector exists (though not yet introduced into this country) in the form of the toothed ribbon (Fig. 5). These ribbons come in a width of $3^1/_2$ in. and in lengths of $3^1/_2$ to 35 in. Over an area of $3^1/_2 \times 3^1/_2$ in. they are provided with 18 teeth on each face, and their safe shear value is rated in Europe at 135 psi at any angle with the grain. This compares well with the safe shear strength of the best American timbers, which is about 120 psi. Inasmuch as the teeth are small, it is possible to drive them into the timbers merely by hammering, without special clamping devices. The timbers are then secured with bolts on about $10^1/_2$-in. spacing or with nails on about 1-in. spacing.

A comparison of all connectors brings out again the fact that small but numerous intimate contacts with the timber develop the greatest rigidity and equal strength at any angle of load to grain. An increase in the size of the contacts demands a decrease in their number and brings with it a drop in rigidity and a marked difference in strength perpendicular to the fiber as compared to that parallel with it. Usually, the area available for the connection of a given force is limited, and it is therefore well to know which connectors will develop the greatest strength in a given area. The area taken up by a connector may be roughly determined by multiplying the minimum permissible spacing in the direction of the load with that perpendicular to that direction. If, then, the safe load of the connector divided by this area is called its joint efficiency, it is found that among group 1 the toothed ribbon is the most efficient with 135 psi. For the smallest size of the toothed ring this figure varies from 135 to 110, depending on the angle between direction of load and the grain. The corresponding figures for the largest toothed ring are only 95 and 70.

The most favored connector is the split ring. Its two smallest sizes ($2^1/_2$ and 4 in. diameter) develop in nondense structural grades of Douglas fir or southern pine a joint efficiency of 200 psi parallel with the grain and 140 psi at an angle of 90 deg. Again, these figures drop for the larger sizes. The 8-in-diameter ring rates only 100 and 50, respectively.

Of course, many considerations enter into the selection of the most suitable type and size of connector, so that no general preference can be recommended. Where it comes to a choice between connectors and bolts, however, there can be little indecision. The superiority of the former is so well established that the only attractions remaining in favor of bolts are convenience or economy. Even these are often illusions caused by habit or optimism. The advantages of the connectors compared to bolts are chiefly these: They insure greater rigidity, their joint efficiency is higher, they utilize a greater part of the cross section of the connected members, and their strength is less affected by shrinkage. More detailed information may be found in the literature cited in the bibliography at the end of this paper. That the connectors are worthy of the engineer's attention is best brought to mind by the many impressive structures that they have inspired. A few examples are shown in Figs. 6 to 8.

CHEMICAL ADHESIVES

An effect similar to that of the toothed ribbon or of closely spaced nails can be obtained by the use of glues. They too act on the principle of numerous small contacts spread over large areas. The safety of such connections is proportional to the number of their elementary parts. If this is not realized, it may easily lead to undeserved rejection. Just as it would be a mere guess to predict the length of life of one individual, so it would be unsafe to rely on the proper performance of, for instance, a single nail. But as the average life of fifty persons can be rather closely computed so can the safety of fifty nails. The greater the number, the closer is the approach to certainty. This incidentally explains why the individual nail may not be accepted as a dependable connector, yet nailed structures have a creditable record of rigidity, safety, and permanence.

Likewise glue, while it cannot be recommended for joining small areas of contact, furnishes an efficient bond for the large areas of contact, for example, between the flanges and the web of a girder. This same thought induced the inventor of the nailed truss to provide it with so many web members that it is more nearly a girder, offers ample room for a great number of

nails, and thereby gains in safety.

Inasmuch as the glues used for structural purposes are always applied to large surfaces, they must be cold glues and must not set too quickly. On the other hand, they must have high strength and be durable. The glue which meets these requirements best is the casein glue. It is available in the form of powder and is mixed with water at a temperature of from 70 to 90 F. It is spread on the timbers with brushes and will start setting after about 20 min. Within that time the timbers must be placed into a press which will exert an average pressure of 100 to 200 psi. The glued sections remain in this press from 6 to 24 hours, depending on various conditions.

Preferably, the ultimate shear strength of the glue should be equal to that of the timber. Indeed, if 100 casein-glued specimens of Douglas fir or southern pine are tested, about 67 will fail in the timber and 33 in the glue joint. The latter figure is approximately the percentage of specimens which would be expected to have a higher ultimate shearing strength than average. Casein glue is also water-resistant though not waterproof. It can be relied upon, therefore, only where the structure is protected against the weather and not continuously exposed to condensation.

A more recent development is the synthetic-resin glues. They develop not only sufficient strength but are also waterproof. At the present time, however, they require the application of heat combined with pressure. They also set very quickly; therefore they are not yet suitable for structural purposes except for structural plywoods.

As the connectors made it possible to join timber elements together in imposing structures, so have the glues enabled the designer to im-

FIG. 8 ARCHED TIMBER-CONNECTOR BRIDGE, 180-FT SPAN, 15-TON LOADING, AT MONTEREY, CALIF., DESIGNED BY CALIFORNIA STATE HIGHWAY COMMISSION AND CONSTRUCTED OF CALIFORNIA REDWOOD

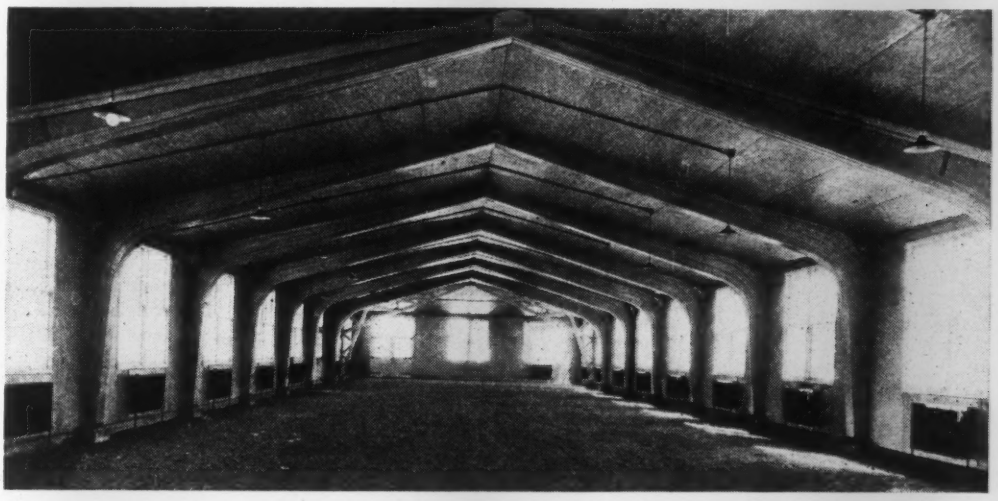

FIG. 9 FOUR-YEAR-OLD STRUCTURE BUILT AT MADISON, WIS., UNDER DIRECTION OF U. S. FOREST PRODUCTS LABORATORY

(Arch in foreground has plywood web and glued flanges. Next five arches are glued solid. Arch in the rear is trussed. Plywood walls and surface-stressed roof panels are of Douglas fir. The plywood, $^5/_8$ in. thick above and $^3/_8$ in. thick below, is glued and nailed to top and bottom edges of 2 × 6-in. purlins. Arches have a span of 46 ft, a height at center of 17 ft, $7^1/_2$ in., and a spacing of 16 ft. Courtesy U. S. Forest Products Laboratory.)

FIG. 10 THREE-YEAR-OLD CASINO AT CAMP UNITY, WINGDALE, N. Y.

(Arches are glued solid and are carried on foundations outside the building. Arches have a span of 89 ft, a height to center of 34 ft, and a spacing of 18 ft.)

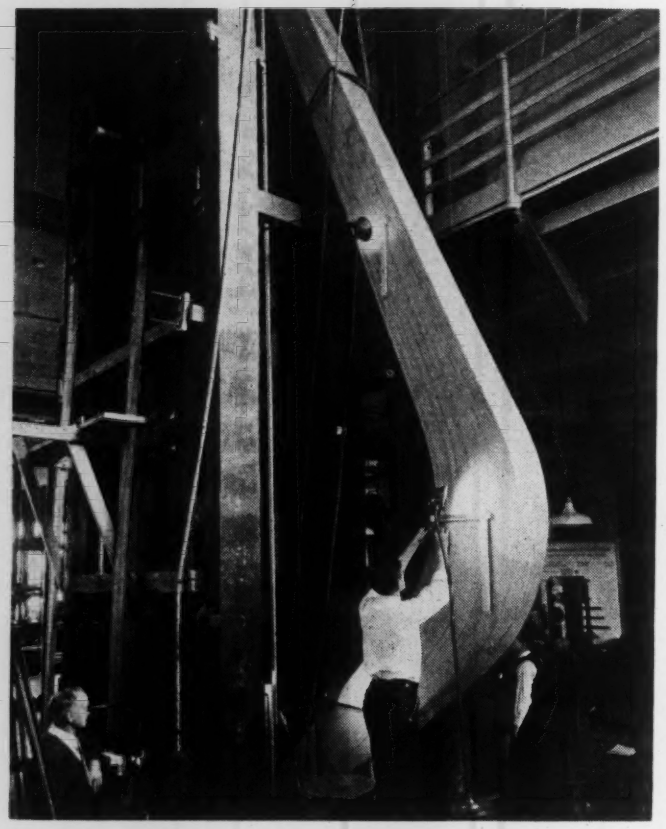

FIG. 11 TESTING ONE HALF OF ONE OF THE ARCHES OF FIG. 9 AS A BENT COLUMN

prove on the elements themselves. Nature furnishes them only in limited sizes. For instance, an 18-in. timber is difficult to obtain out of local stock. Such timbers too are subject to considerable checking and often are not available in the desired grade or length. The glue makes it possible to build up sizes even larger than 18 in. from parallel laminations of lesser thickness. The grade of these laminations can be adapted to the stress distribution over the cross section, so that the strongest are on top and bottom and the poorer ones in the center. Such built-up beams will check very little and will, if properly glued, have a more uniform strength than solid timbers. Beams of large size have of course been built up also by means of connectors (doweled beams), but the glue has the advantages that shrinkage is less likely to influence its strength and that it does not reduce the cross-sectional area.

Other structural elements that have become available with the aid of glue are timber gusset plates for trusses and webs for girders. They are on the market under the name of structural plywoods. They too are built-up from laminations. These are not parallel, however, but alternately disposed against each other under an angle of 90 deg. The maximum thickness of waterproof plywood (hot glued) is about 20 laminations of $\frac{1}{8}$ in. each. Water-resistant plywoods (cold glued) have been used in thicknesses up to 49 plies ($6\frac{1}{8}$ in.). Tests on structural plywoods have been made by Benkert, Hanrahan, and Smith at The Pennsylvania State College and by Harry A. Williams at Stanford University.

Glue also makes it possible to combine timbers and plywoods into girders and surface-stressed panels or frames. It has its greatest value, however, in arch construction because it is the only practical means of manufacturing long curved members. These members may be joined to solid arches, or they may form merely the flanges of a curved girder or the chords of a trussed arch. Applications of glued construction are shown in Figs. 9 to 12.

CONCLUSION

Compared to steel and reinforced concrete, timber has for a long time been neglected as a structural material. Though great progress has been made lately in timber construction, too little of it is yet known among the architectural and engineering professions. An increased use of timber for structural purposes is in the interest of the public and will lead to further improvements in the art of design.

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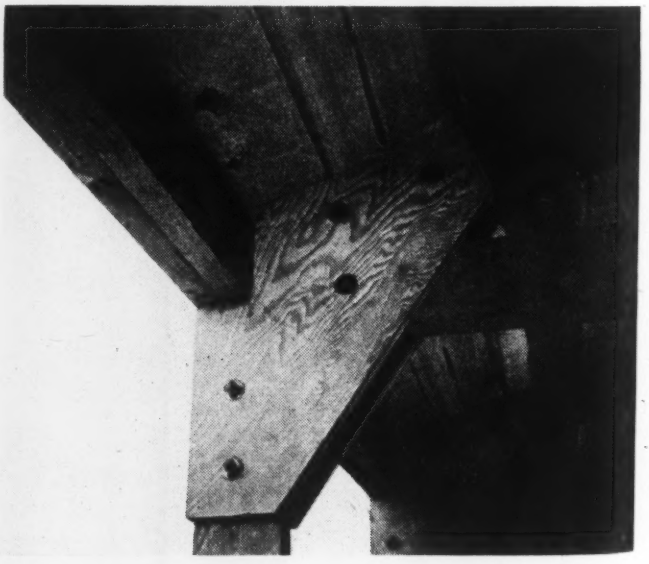

FIG. 12 GUSSET PLATES OF DOUGLAS FIR STRUCTURAL PLYWOOD

The PLACE *of the* DIESEL ENGINE *in* OUR NATIONAL DEFENSE

By J. E. B. McINERNEY

CAPTAIN, ORDNANCE DEPARTMENT, U. S. A., WASHINGTON, D. C.

I GREATLY appreciate the honor of being selected to present to your Society my views on a subject which, in my opinion, is of vital importance to all who are associated with the problems of our national preparedness. It is not my intention to dwell on the highly technical features of the subject but rather to outline briefly for you facts which will give a true picture of the place of Diesel power in our national defense.

When I first took over my assignment at the Ordnance Office in Washington I found these definitions under the glass top of my desk:

"An engineer is said to be a man who knows a great deal about very little and who goes along knowing more and more about less and less until finally he knows practically everything about nothing; whereas

"A salesman, on the other hand, is a man who knows very little about a great deal and keeps knowing less and less about more and more until he knows practically nothing about everything."

In my capacity as the assistant to the officer in charge of the Automotive Section in the Office of the Chief of Ordnance I am supposed to be both an engineer and a salesman. As an engineer I am partly responsible for the design and development of Ordnance automotive material, and as a salesman I must sell our ideas to the officers of the using services, the Infantry, the Cavalry, and the Artillery. There are many times in my experience when I feel the definitions which I have just quoted for you are most applicable.

The subject which I am about to discuss for you this evening, "the place of the Diesel engine in our national defense," is indeed a broad one. I hope you will appreciate that from experience I am only qualified to discuss this subject from the Army Ordnance point of view. I shall endeavor, however, to present to you the broader picture as I see it in its relation to our national defense.

I should like to stress that the ideas expressed by me are my individual beliefs and are not the official opinions of any of the branches of the Army or the Navy on the subject of Diesel engines.

I think it was Calvin Coolidge who said: "To find out what should be done we must first find out what has been done," or, so as not to be considered partisan in my references, I will quote one of our recent unsuccessful presidential candidates, who said: "Let us look at the record." It would be well at this time to review briefly the points for and against the Diesel engine and its development. What are its limitations? What are its principal advantages and disadvantages? Its outstanding rival is the gasoline engine, so let us compare the two.

If we examine the accessories which are necessary for the gasoline and the Diesel engines we find that, whereas the Diesel has no spark plugs, it has injector units; the ignition distributor of the gasoline engine is replaced by a fuel distributor or pump; batteries, generators, and starting motors are common to both engines. In general, the cost of the accessories for compression-ignition engines is greater than that for the gasoline engines.

When we consider the comparative weights per horsepower of the gasoline versus the Diesel, it must be evident that the Diesel will always be the higher. The explosive pressures of the Diesel engine being considerably higher than those of the gasoline engine for the same brake mean effective pressure, heavier parts are required for the Diesel. The weight may be reduced by using more alloys of higher physical properties, but this in turn increases the cost of the engine. Owing to any slight degree of improper adjustment in the fuel supply system, excessive pressures might develop and as a result, the safety factor must be greater than in a gasoline engine.

The initial cost of the Diesel engine will probably always be higher than that of the gasoline engine. The price differential will drop when more Diesel units are produced in larger quantities. This higher initial cost is an important consideration for the naval and military services in time of peace, since more gasoline units for training may be procured from the limited appropriations. It is true that the fuel economy of the Diesel will offset this initial cost, but only provided the hours of operation per year are sufficiently high. In the military and naval services the hours of operation per year for any unit are, in general, limited by the appropriations for fuel. The advantage of fuel economy is one of great interest from a military *design* viewpoint. With limited fuel storage capacity, it affects both cruising radius and pay load. However, the increased weight of the Diesel engine in many cases offsets any advantages gained from better fuel economy.

When compared with the gasoline engine, the Diesel engine, because of its higher compression ratio, has a greater thermal efficiency; which simply means that the gasoline engine throws out more useful heat units in the exhaust gases than does the Diesel engine. As a result of this higher efficiency of the Diesel engine, more heat is put into useful work and less is available for causing troubles. It is estimated that about 60 per cent of our troubles with internal-combustion engines result from excessive heat flow.

The economic advantages resulting from the better specific fuel consumption of the Diesel engine and from the use of a fuel which is at a lower basic price level are admitted. Fuels are sold by volume and since Diesel fuel is heavier than gasoline there is an added advantage in terms of pounds of fuel per brake horsepower for the Diesel engine.

The price of Diesel oil, like any other commodity, is controlled by the law of supply and demand. As more extensive use is made of the Diesel engine the price differential between gasoline and Diesel fuel will naturally be reduced.

The following statistics taken from the April, 1939, issue of the *Commercial Car Journal* may be of interest:

An address delivered at the Twelfth National Meeting of the Oil and Gas Power Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, held at the University of Michigan, Ann Arbor, Mich., June 19–22, 1939.

Released for publication by the Chief of Ordnance, U. S. Army. Statements and opinions are to be understood as individual expressions of their author, and not those of the Ordnance Department.

"Thirty-six states now have the same rate of Diesel-fuel tax as gasoline, the rate varying from $6\frac{1}{2}$ cents to 2 cents per gallon. There are nine states and the District of Columbia which have a gasoline tax but no Diesel-fuel tax. New Mexico has a 5-cent tax on gasoline and $7\frac{1}{2}$-cent tax on Diesel fuel. In Utah, Diesel vehicles on public highways are taxed $1\frac{1}{8}$ cents per operating mile whereas the gasoline tax is 4 cents per gallon. Delaware, Massachusetts, Oregon, Vermont, and Washington have higher license fees for Diesel-engined vehicles than gasoline vehicles. There is a 1-cent per gallon federal gasoline tax but none on Diesel fuels." It is appreciated that these figures have no direct bearing on the use of Diesel-engine vehicles in the government service.

The outstanding advantage in favor of the Diesel engine from a military and naval viewpoint is the use of a nonvolatile high-flash-point fuel which practically eliminates the explosion and the fire hazards. This is of the utmost importance when fuel must be stored and transported in the combat zone and on ships. The use of Diesel fuel instead of gasoline in our vehicles and sea craft would greatly improve the morale of the operating personnel. And did not Napoleon imply that he would rather have one man with high morale than three without it? In our vehicles, the use of gasoline fuel necessitates the permanent installation of fire-fighting equipment. This feature is an added expense and occupies space in already overcrowded vehicles.

Another distinct advantage from a military and naval point of view in favor of the Diesel engine is the absence of high-tension-ignition radio interference. The need for ignition shielding is eliminated and we are further assured that the radio will more properly serve its purpose.

The absence of poisonous gases in the exhaust of the Diesel engines is greatly in its favor, but on the other hand, the smoke in the exhaust at certain speeds is a very undesirable feature from a tactical military point of view.

The greater noise of the Diesel engine is also a phase which should be given some consideration in deciding on the use of this engine for military purposes.

Higher-grade lubricating oils are required for Diesel engines than for gasoline engines, due to the higher peak temperatures.

One of the great inherent faults of the high-speed Diesel engine is the difficulty of cold-weather starting. We have had some success with cartridge-type starters, but there is still much to be desired.

The maintenance and repair costs of Diesel and gasoline engines may be considered about equal.

Having compared these two types of internal-combustion engines, let us see what has been done and is being done by the organizations charged with the responsibility of preparing for our national defense, in the way of making the most efficient use of the Diesel engine. In covering the entire field I shall endeavor to show what is being done by the Merchant Marine, the Coast Guard, and the different branches of the Navy and the Army.

MERCHANT MARINE

In any war we would have to depend to a great extent on the preparedness of our American merchant marine. From a paper prepared and delivered to the Washington Section of the A.S.M.E. by John E. Schmeltzer, assistant director, Technical Division, U. S. Maritime Commission, I find the following data: "As part of its building program the Maritime Commission has entered into direct contracts with four shipyards for the construction of twenty cargo vessels, half of which will have Diesel propulsion with a requirement of 6000 shp normal but capable of continuous operation at 6600 shp. The Commission has also awarded contracts for four Diesel-driven cargo ships and four Diesel-driven combined cargo and passenger ships from various shipyards. These latter Diesels will have a requirement of about 8500 shp."

Concerning the factors guiding the use of the marine Diesel, the following is quoted from the same paper: "From 50 horsepower to 500 the semi-Diesel or Diesel is supreme including Diesel-electric for tugs. From 500 to 2500, it is the Diesel with some competition from uniflow steam engines and Diesel-electric for tugs. From about 2500 to 10,000, between Diesel and steam turbines it is anybody's battle. The longer routes favor the Diesel and the shorter, say below 3000 nautical miles, favor the turbine. Above these powers the balance goes slightly, and then absolutely, in favor of the turbine although there are a number of high-power Diesel drives."

It has been the experience of marine-Diesel operators that with the higher speed Diesel engines there has come a demand for higher grade fuels. Difficulty has been experienced in obtaining the proper grade in foreign ports. The Navy is not troubled with this problem as they can store large supplies of the proper grade fuel at the various naval bases.

The trend toward more extensive use of marine Diesel engines may be seen from the fact that the output for high tonnage ships increased from 984,000 ihp in 1937 to 1,199,000 ihp in 1938. It is also interesting to note great progress has been made in the two-cycle engine, and it is estimated that engines of this design are installed in about 50 per cent of the motor ships in existence. It was reported by Lloyd's register of shipping in January of this year, that motor ships accounted for 65 per cent of the total or 1,743,834 of the 2,668,864 gross tons of merchant-ship construction throughout the world.

COAST GUARD

The United States Coast Guard has at the present time, in addition to all other craft, approximately 100 boats that are powered by Diesel engines. The approximate total shaft horsepower of this fleet is about 60,000 with Diesel-engine auxiliaries totaling an additional 5000 hp. The type of boats in which Diesels are used are the following: Arctic cutters; harbor cutters; patrol boats ranging in size from 100 ft to 165 ft; anchorage and boarding boats; and lifeboats.

Diesel engines as a whole have proved themselves particularly well-adapted to coast-guard service and are coming more and more into general use. The advantages from the coast-guard point of view of the Diesel engines are: quick starting in case of emergencies; full power available on short notice; very little stand-by loss; flexibility of operation particularly when used in connection with Diesel-electric drive. The greatest drawback at the present time that has been encountered is the lack of enough facilities for storing, handling, and distributing a proper quality of fuel. When the facilities for these functions have been increased to a greater extent, lifeboats and rescue boats will probably be powered with Diesel engines instead of gasoline engines.

It is now becoming the standard practice to install emergency Diesel generating plants aboard the larger steam cutters for maintenance of communication, lighting, and power.

NAVY DEPARTMENT

In discussing the development work and the current use of the Diesel engines by the Navy Department, I shall first consider the marine installations which come under the Bureau of Engineering, and then the aircraft side of the picture, which is under the Bureau of Aeronautics.

Among the advantages possessed by the Diesel engine, from a naval-engineer's point of view, are the following:

1 Economy in space required within the ship, particularly if bulky boiler uptakes are taken into consideration.

2 Weight per shaft horsepower compares favorably with the best of the steam plants of equal reliability.

3 It is as reliable as, but much more economical than, the steam plant.

4 It is much less vulnerable than a steam plant, which requires high-pressure steam piping, which proved a great source of danger in naval engagements during the World War.

5 Ability to start quickly and develop full load in a very short period of time.

6 Greater availability than steam plants.

7 More adaptable to the propelling-plant requirements peculiar to naval vessels.

The navies of the world have appreciated the advantages of the Diesel engine for their purposes and have contributed much toward its development. It is of interest to note what developments were taking place when foreign navies were expanding more quickly than our own.

When the program for rebuilding the German Navy was resumed, satisfactory Diesel engines for propelling warships were not in existence. However, there were available Diesel engines of sufficient horsepower to be used for cruising purposes only and these were carried as dead weight when the steam turbines were in operation. Their application for this purpose, however, was very limited. In the latter stages of the German naval-development program, Diesel plants furnishing 54,000 shp were produced and installed in the so-called pocket battleships.

In these pocket battleships all engines are directly reversible and the four engines which are geared to one propeller shaft can be maneuvered as a group by one lever, or individually, if necessary.

Other foreign navies, including the French, Norwegian, Japanese, and Polish, have developed Diesel naval engines as propelling plants for their large naval craft. In most of these power plants the two-cycle Diesel engine is used.

Our own Navy Department makes extensive use of marine Diesel engines and by its sponsoring of many new types of compression-ignition engines has done much toward developing the modern high-speed Diesel engine. In March, 1932, a circular letter was addressed to all Diesel-engine and a number of gasoline-engine builders, inviting them to submit proposals for a unit consisting of a high-speed Diesel engine and a generator. By December, 1932, five companies had signed contracts with the Navy to deliver either complete units of desired size, or parts of units capable of expansion into the sizes desired by the Navy.

The Navy uses a great number of Diesel engines, of both the two-cycle and four-cycle principle of operation, as stand-by generator units on board ship to supply electrical energy in emergencies, when the normal source of it fails to be available. These are high-speed engines ranging from about 1200 to 1800 rpm. For propulsion of submarines the Diesel has no rival.

Experimental work is being carried on with three qualified Diesel-engine builders to construct and test experimental two-cycle engines of about 700 hp per cylinder for use in auxiliary ships of the fleet.

Coincident with the development work in Diesel engines, the Navy Department has also carried on experimental work at the Engineering Experiment Station at Annapolis, in the investigation of the properties of Diesel-engine fuels.

For much of the foregoing information I am indebted to E. C. Magdeburger of the Bureau of Engineering, Navy Department.

NAVAL AIRCRAFT

Since it was organized in 1921, the Bureau of Aeronautics of the Navy Department, fully realizing that the real advantages of satisfactory engines operating on the Diesel cycle, from a naval and military standpoint, were such as to warrant continued development, has consistently set aside funds and contracted for aviation Diesel engines from firms of outstanding engineering reputations. Due to the inability of some firms to produce engines meeting the contract requirements, all of the money set aside has not been paid to the industry. However, the development program which was initiated by these funds has provided a wealth of information from which both the industry and the Navy have benefited.

As early as 1924, at a time when it was considered impracticable to build a light, high-speed Diesel engine, the Bureau of Aeronautics contracted with an engineering firm for a small aviation engine of 120 hp designed by Andre Attendu. This engine when built proved to be impracticable in certain features, but clearly demonstrated that it was feasible to operate a Diesel at high speeds. Encouraged by the results of this test, other firms were willing to contract to build satisfactory aircraft Diesel engines for the Navy. One of these engines was a large 6-cylinder, 900-hp engine for airship use. The undertaking was never completed but the experience gained with this project permitted the development of one of the most successful railroad Diesel engines now on the market.

A number of other firms which had been building large industrial Diesel engines and also manufacturers of gasoline engines, after spending millions of dollars, decided that the high-speed Diesel engine for aircraft purposes was still in the experimental stage.

Of the companies which built aircraft Diesel engines during this period, the Packard Motor Car Company had the greatest success. In the fall of 1929 a long-distance flight from Detroit to Miami was successfully made in a plane equipped with one of Packard's radial Diesel engines. In May, 1931, a Bellanca plane powered with a Packard Diesel engine established a new nonrefueling world's endurance record of 84 hr and 3 min. The development work of the Packard Company was under the late Capt. L. M. Woolson, with Dr. Dorner, a German Diesel-engine expert as consultant. Due to the death of the designer and the financial crisis which started in 1929, the Packard development was discontinued.

In 1934 another Diesel-engine company was willing to guarantee a reasonable performance on a contract for one of its engines. This engine was similar in many respects to the Packard engine. One of the engines made by this firm was flight tested. The results of this test were sufficiently satisfactory to warrant a contract in May, 1937, for an air-cooled engine, rated at 500 hp at 2200 rpm supercharged to 5000 ft.

WAR DEPARTMENT

In presenting to you the Army side of the picture I shall endeavor to show what has been done and is being done by the Quartermaster Corps, the Engineer Corps, the Air Corps, and the Ordnance Department.

QUARTERMASTER CORPS

The Quartermaster Corps is charged with the responsibility for the design, development, procurement, maintenance, storage, and issue of all those vehicles of the Army adapted for general purposes, such as hauling cargo, ammunition, personnel, and equipment, and for the towing of guns, trailers, and other wheeled equipment as distinguished from combat or fighting vehicles for which the Ordnance Department is responsible.

The experiences of the World War and the number of makes and models of motor vehicles (over two hundred in the military service), indicate an imperative need of a satisfactory system of standardization of military motor vehicles, both in war and

peace. Army regulations direct that the numbers of makes, models, and types of motor vehicles will be kept to the minimum consistent with the laws and regulations governing procurement, and also require that a complete list of military characteristics will be published by the Quartermaster General for each fiscal year.

The War Department policy with reference to procurement and standardization of military motor vehicles is as follows: The procurement of motor vehicles, other than combat vehicles, will be limited to models produced commercially by two or more competing companies, and available at reasonable prices; and with the minimum deviation from standard commercial chassis necessary to conform to approved military characteristics set up for the using arm or service to which the vehicle is allocated; the parts and unit assemblies so used to be standard production in the automotive industry.

With this as a directive it is not believed that the Quartermaster Corps has felt that the Diesel engine has reached the stage where they would be justified in procuring for the using services Diesel-engined trucks. Diesel-engine production facilities of the United States for trucks and bus es at the present time, as compared to the production facilities for gas engines for the same purposes, are very limited. Further, the present status of the development of Diesel engines for automotive purposes might be compared to the status of the development of the gasoline engine fifteen years ago. While rapid progress in the development of the Diesel engine is being made, this development is being retarded at the present time due to the cost differential between the Diesel and the gasoline engines. In war time, when the hours per year of operation would be greatly increased, the economy of operation would offset the greater initial cost and undoubtedly Diesel-engine trucks for general army purposes would be in demand.

However, in this respect the question of fuel supply would have to be given consideration. The use of Diesel engines would involve the supply problem to the extent that an additional type of fuel would be required. However, the bulk of Diesel fuel required for the same tons per mile per gallon of operation would only be about 40 per cent of that required for gasoline engines. For the engines operating in the combat zone the importance of the reduced fire hazard cannot be too highly stressed.

In addition to the truck and bus type of engine, the Quartermaster Corps is responsible for the procurement of marine engines. These are installed in mine planters, cable layers, army transport ships, and also crash boats for the Air Corps.

In December, 1937, the Quartermaster Corps procured for the Coast Artillery Corps a Diesel-electric vessel, *Ellery W. Niles*, as a combination mine planter and cable layer. This vessel, the first of its kind, performs the distinct functions which were formerly handled by two vessels—cable laying and mine planting.

This is an experimental vessel but the selection of the Diesel-electric propelling unit was made because of the long cruising range and the reduction of the fire hazards. The ship has a cruising range of 10,000 miles at a speed of 10 knots and can remain at sea 21 days without returning to its base.

In time of emergency the Quartermaster Corps would also procure Diesel-engine units for stand-by electric power plants, refrigerating plants, air-conditioning plants for hospitals, pumping stations, and the like.

CORPS OF ENGINEERS

The Corps of Engineers is charged with the responsibility for the design, development, and procurement of all general rolling stock, including motive power for military railroads. Diesel power for construction equipment, such as air compressors and power shovels, has not appeared to the Engineer Corps to have enough advantages to be used very extensively for peacetime military purposes. It is felt that the high initial cost of the Diesel engine is not economically justified due to the low application factor.

It is believed that for mobile or portable antiaircraft searchlight power plants there are outstanding possibilities for the use of Diesel engines. However, up to the present time favorable consideration has not been given to the application of the Diesel for these purposes. In order to determine definitely the suitability of present Diesel power to this type of equipment, procurement has been initiated for an experimental portable searchlight unit. Extensive acceptance and field service tests will be conducted to determine the suitability of this type of engine.

Power plants for fixed locations, such as seacoast fortifications, are normally Diesel-powered. Such power plants for these installations have been in general very satisfactory and range in size from 35 to 360 kw.

AIR CORPS

Although there is not the same urgent need for a satisfactory Diesel aircraft engine by the Air Corps of the Army as there is for ship-borne observation and scout planes of the Navy, the Air Corps, being aware of the advantages of this type of engine for military purposes, has not neglected its development.

In March, 1935, specifications were drawn up for the Diesel engine of a horsepower comparable to that of gasoline engines now in general aircraft use and were sent to those engineering companies which were believed to be in a position to bid on them. As a result of these proposals, contracts were awarded for development work on Diesel engines in June, 1935. The initial test running of the engines, developed as a result of these contracts, showed a number of troubles which are inherent in high-speed Diesel engines. As is well known, all the nations of the world have had trouble in their experiences in Diesel-engine development with piston rings, cylinder heads, sleeves and sleeve-valve drive mechanisms, and fuel metering. The tests have shown that considerably more research is necessary before successful endurance tests could be completed. At the present time, four years after the date of the contract, the endurance tests required by the contract have not been completed.

Considerably more research and development on aircraft Diesel engines has been done in Europe than in the United States. This emphasis abroad on the development of the aircraft Diesel engine is due to the fact that these countries carrying on such development do not have within their boundaries satisfactory fuels for high-performance gasoline engines such as are required in modern military aircraft. Such countries can foresee the possibility of having their supply of satisfactory gasoline fuel for military aircraft cut off in time of war. In spite of the known danger of scarcity of aviation gasoline in war, by far the greater percentage of military airplanes in Europe, including the countries carrying on the Diesel development, are still equipped with gasoline engines where high output is required.

There is a growing interest in this country in the use of safety fuels having a flash point of about 110 F to be used with fuel-injector units in engines operating on the Otto cycle. The successful use of this type of fuel and injector unit eliminates the fire hazard and also troubles due to carburation.

The Air Corps feels that there are sufficient inherent advantages in the use of the Diesel engine to continue the study and observation of its development. Every effort is being made to obtain a Diesel engine having a performance as good or better than that of the aircraft engines which are now available.

Most improvements in Diesel-engine performance have, up to the present time, been counterbalanced by corresponding improvements in gasoline-engine performance. This is one of the factors which makes the problem of the development of a satisfactory aircraft Diesel engine so difficult.

ORDNANCE DEPARTMENT

Among the many problems of the Ordnance Department is that of furnishing automotive combat vehicles to the fighting arms. The Quartermaster Corps procures the motorized equipment, whereas the Ordnance Department furnishes the mechanized units. Mechanization, as it refers to war, may be said to be the adaptation of the best-known mechanical features of the existing times to the weapons of war. Recently, the term has been restricted to the use of automotive vehicles for combat purposes.

The World War, because of the extensive use of automotive fighting vehicles, is the popular conception as to the time when mechanization was first adapted to war weapons. The importance which our World War leaders placed in mechanization may be gained from the fact that when the Armistice was signed there were on order over 22,000 tanks to be used in the 1919 offensives.

The recent wars in Spain and Abyssinia have clearly indicated that the machine is superior to the man. A mechanized unit of approximately 500 officers and men can produce the same fire power, have greater protection and mobility, and be cheaper to maintain than are approximately 3000 officers and men of an infantry regiment. It may be concluded that modern war will be one of machines, which will be required in astonishingly large quantities.

There is no commercial demand for the types of vehicles which are required by our combat arms. The requirements of high speed for strategic mobility and for cross-country tactical mobility are such as to require high-speed, full-track-laying vehicles. In designing these special-purpose vehicles it is the policy of the Ordnance Department to use as much as possible commercially available units, such as transmissions and engines. In our combat vehicles the weight and space factors of the engine are of paramount importance.

The many practical advantages of the Diesel engine are well-known to the Ordnance Department and to the personnel of the fighting branches of the Army. The absence of the fire hazard, the economical fuel consumption, improved torque which requires less shifting of gears, the elimination of radio shielding, the use of a fuel with a nonpoisonous exhaust, and the other advantages are such as to require that a maximum of effort be made to procure a satisfactory Diesel engine for our special purposes.

It might be well at this time to digress from the main subject and discuss the procedure through which a piece of Ordnance matériel passes, from the original proposals to the time it is placed in the hands of troops. The chief of the using arm lays down the tactical requirements based on the general principles established by the General Staff. With these requirements as limitations, the Ordnance Department will make a design, if and when the project and the expenditure of funds are approved by the Ordnance Technical Committee and the War Department. The Ordnance Technical Committee is composed of representatives of the chiefs of all the using and combat services, in addition to the members of the technical divisions of the Ordnance Department. Before any money can be spent on a project, it is necessary to have the written approval of the committee which, in turn, means that no money can be spent without the written approval of the chiefs of the using service through their official representatives. This procedure applies to major modifications as well as to a complete new design.

After completion of the design, a pilot unit is built and sent to Aberdeen Proving Ground for engineering and technical tests. Pilot units are tailor-made and are naturally expensive. Many changes are usually found necessary during the test, which greatly add to the cost. After the proving-ground test, with any necessary changes having been made, the pilot is sent to the using arm for service test. As a result of this test, the chief of the using arm either recommends that the piece of matériel be adopted as standard or that certain changes are necessary or desirable. The Ordnance Department, based on these recommendations, will make the changes, if practicable, or will make a new pilot to meet the requirements of the using service. When these requirements are met the piece of matériel is then approved as standard by the General Staff upon the recommendation of the Chief of Ordnance and the using service. The unit is then released for production.

It must be quite apparent from this procedure that items of Ordnance equipment are never adopted, or supplied to the using arm, at the mere whim of an individual, and before any funds are expended for Ordnance items, approval must first be obtained according to the procedure just outlined.

Let me read for you an extract from a letter, of October, 1933, from the Chief of Staff of the Army to the chairman of the Military Affairs Committee of the House of Representatives: "I assure you of my deep interest in this whole matter. I am instructing all technical services of the Army to seek opportunities for increasing efficiency and obtaining additional economies through the utilization of Diesel engines wherever advantage may be taken of their peculiar capabilities and characteristics."

With this as a directive the Ordnance Department has, during the last four years, spent a considerable sum of money in procuring a number of Diesel engines of a type which would suit our requirements as to weight, space, and performance. The first of these engines was procured and tested in 1935. The results of the test were sufficiently encouraging to warrant the procurement of a number for service test. When these engines were functioning satisfactorily the using services were most enthusiastic about their performance. The service test has indicated that there are a number of defects in this engine which may be eliminated without any radical changes in design. The manufacturer has been making single cylinder tests and believes that he has solved his problem without any major changes in design.

Recently we have procured from one of the leading firms in the production of Diesel bus and truck engines, an engine for test. Although this engine is heavier, more bulky, and does not have the horsepower requirements of the present gasoline engine, it does have the required torque characteristics and it will permit us to determine the general adequacy of this type of engine for our purposes. Should it prove adequate, the field will be open to all producers of commercial Diesel engines which will meet our requirements.

In addition to combat vehicles the Ordnance Department is responsible for the procurement of all track-laying vehicles. The number of tractors which would be required in war may be judged from the number, 25,000, which were ordered for the A.E.F. in 1918. The most available tractors would be procured and by far the greatest percentage would be the Diesel-engine type.

In closing, may I briefly review the present picture and the future outlook of the Diesel engine in our national-defense program?

In certain fields, such as propulsion of submarines, auxiliary power in ships, lighting and power plants, searchlights, radio

(*Continued on page 812*)

WHICH FUEL TO CHOOSE?

Comparative Economy of Generating Steam With Anthracite, Bituminous Coal, and Fuel Oil for Industrial Plants in the New York Area

By GOSTA A. ANBRO

COLGATE-PALMOLIVE-PEET CO., JERSEY CITY, N. J.

FACTORS involved in an analysis of the comparative economy of generating steam with anthracite, bituminous coal, and fuel oil for industrial plants in the New York area, will be considered under the following subdivisions:

1 Cost of fuel.
2 Effect of fuel on plant efficiency.
3 Effect of fuel on steam and power consumption.
4 Effect of fuel on repair material costs.
5 Effect of fuel on labor requirements.
6 Refuse disposal.
7 Investment in changed and new equipment.

COST OF FUEL

If an investment in fuel-burning equipment is contemplated, the consideration of fuel cost will involve some judgment on probable and possible future price trends. Past history is generally helpful in this connection. Fig. 1 shows graphically the price trend of three representative fuels for the last fifteen years. For easy comparison all prices are adjusted to a delivered Btu basis.

The anthracite prices plotted in Fig. 1 are based on the circular prices less 5 cents per ton and on a heat value of 12,000 Btu per lb.

The bituminous coal, whose price figures are plotted in Fig. 1, is one extensively used for dry-bottom powdered-coal installations. The volatile matter in this coal is 28–30 per cent, the ash-fusion temperature is 2500 F, and the heat value is 14,000 Btu per lb. The straight Clearfield freight rate has been used.

The coal prices shown in the graphs of Fig. 1 include rail freight to South Amboy, N. J., plus 25 cents per gross ton boat freight.

The rail freight-rate situation is worth noting. For bituminous coal the rate for delivery on a consumer's siding on the New Jersey shore is 37 cents per gross ton higher than for delivery on a dumping pier. Even if the consumer's siding adjoins the freight yard, it is cheaper to have the coal dumped into a barge and delivered that way. For anthracite there is no such discrimination. As a consequence, for delivery on rail siding on the New Jersey side of the harbor, the anthracite cost is 0.75 cent lower than shown in the graph while bituminous-coal cost is about 0.5 cent higher.

Truck delivery of coal generally increases the cost 1.5 to 3 cents per million Btu.

The oil prices shown in Fig. 1 are based on posted prices plus 5 cents per barrel (6 cents after 1937) boat freight. The heat value has been figured at 6.3 million Btu per bbl.

For truck delivery of oil direct from refinery the cost is at present 0.5 to 1.5 cents per million Btu higher than for delivery by barge. Competition in trucking is keen at present and it is doubtful whether these low rates can be considered permanent.

Contributed by the Fuels Division for presentation at the Annual Meeting, Philadelphia, Pa., Dec. 4–8, 1939, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

It is of interest to note that 54 per cent of the delivered cost of anthracite is freight. For bituminous coal freight is 60 per cent of the cost, while for oil the combined ocean and harbor freight at present probably amounts to about 25 per cent of the cost.

The graphs of Fig. 1 show conspicuously the relative stability of coal costs as compared to oil, on a delivered basis. To a great extent this is due to the stability of coal freight rates against the extreme fluctuations in tanker rates for oil. It remains to be seen whether the additional tanker tonnage, constructed during the last few years, is going to remedy this situation.

In view of the fluctuations in oil prices it is generally too risky to equip a plant to burn fuel oil exclusively. An ideal arrangement, in most cases, is a combined powdered-coal and fuel-oil installation which permits taking advantage of low oil price without interruption for equipment changes. Some small plants in which the costs of coal handling and refuse disposal are high may find it profitable to burn oil even at peak price, in which case a straight oil-burning installation is justified.

As shown by the graphs of Fig. 1 the price relation between anthracite and bituminous coal has changed materially during the last two or three years. Pending government price fixing will probably raise the price of industrial bituminous coals 0.75 to 1.5 cents per million Btu. Even after such a change, anthracite will remain the more expensive of the two fuels except possibly for plants on the New Jersey side which require rail delivery. The outlook for anthracite as an industrial fuel in the New York area is decidedly dark. There is no justification for new anthracite-burning installations except in a few cases on the New Jersey side and even these may be doubtful. The only way to insure the future market for anthracite barley in the New York area seems to lie in an adjustment of freight rates.

EFFECT OF FUEL ON PLANT EFFICIENCY

The difference in efficiency that may be expected with different fuels and firing methods is the subject of much misconception, misrepresentation, and controversy.

It is generally easier to get different opinions into agreement and to arrive at fair conclusions by considering losses instead of efficiency directly. With this in mind the author has set down in Table 1 what in his opinion are the comparative losses and efficiencies. It is hoped that the discussion of the paper will correct any figures which may be considerably out-of-line with majority opinion.

Obviously, losses and efficiencies depend on individual plant arrangement and operation. The intention with the table is not to establish standard efficiencies but only differences due to fuels and firing methods.

The figures for radiation are intended to show the different effects of variable load conditions generally found in industrial plants.

Exit-gas temperatures for oil are appreciably lower than for

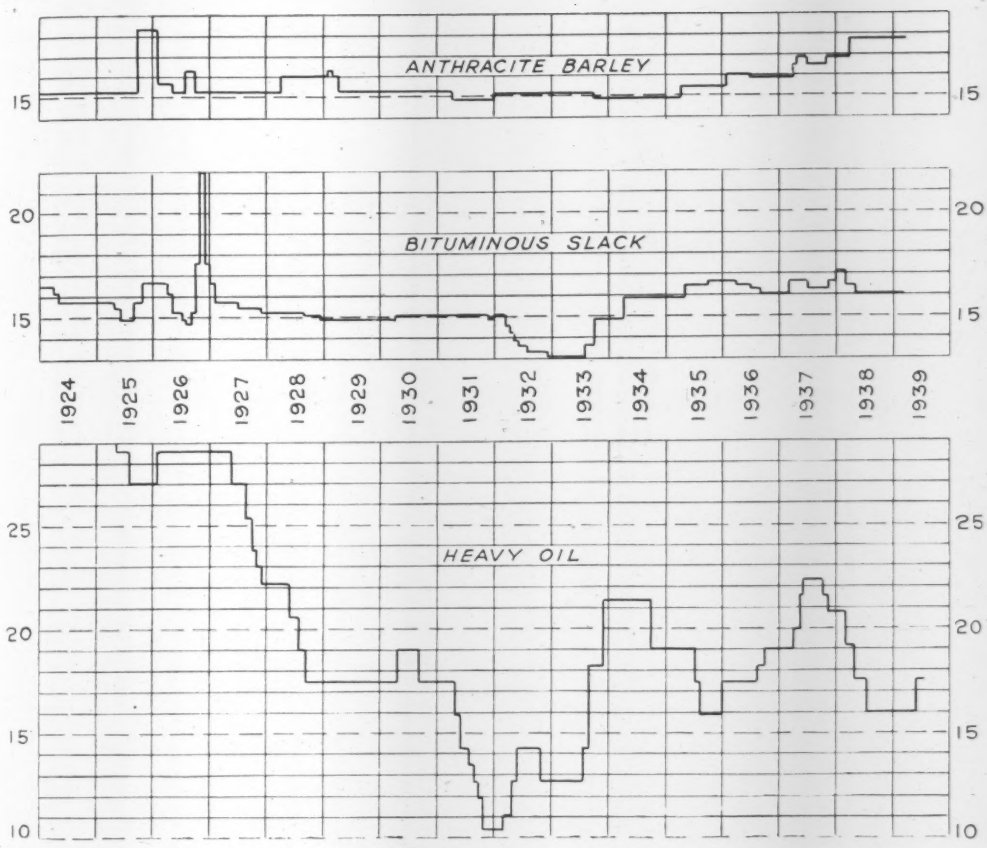

FIG. 1 FUEL PRICES IN CENTS PER MILLION BTU, DELIVERED BY BARGE AT NEW YORK HARBOR WATER FRONTS

TABLE 1 COMPARATIVE LOSSES AND EFFICIENCIES

	Heavy oil	Bituminous coal: Pow-dered	Stoker	Anthra-cite
Average efficient plant				
Excess air, per cent	20	30	40	40
Solid carbon loss, per cent	..	2.0	4.0	5.0
Radiation, etc.,[1] per cent	3.0	3.5	4.0	4.0
With heat recovery				
Exit-gas temp difference,[2] F.	280	295	300	300
Gas and vapor loss, per cent	12.5	11.1	11.5	10.3
Efficiency, per cent	84.5	83.4	80.5	80.7
Without heat recovery				
Exit-gas temp difference,[2] F.	480	495	500	500
Gas and vapor loss, per cent	17.3	16.1	16.7	15.6
Efficiency, per cent	79.7	78.4	75.3	75.4
Inefficient plant				
Solid carbon loss, per cent	0.5	4.0	7.0	8.0
Radiation, etc.,[1] per cent	4.5	5.0	6.0	6.0
Gas and vapor loss, per cent	21.0	20.0	23.0	22.0
Efficiency, per cent	74.0	71.0	64.0	64.0

[1] Includes shutdown and banking losses for variable load.
[2] Above room temperature.

coal. This is in line with reliable records of tests with the two fuels on the same unit. The exit-gas temperatures for powdered coal are set slightly lower than for stoker firing due to the lower excess air.

When excess air and exit-gas temperature have been fixed, the gas and vapor loss is a matter of calculation and not of opinion.

It will be seen that in reasonably efficient plants powdered coal may be expected to give an efficiency about 3 per cent higher than stoker firing, other conditions being equal. The efficiency for oil firing may be expected to exceed that for powdered coal by about 1 per cent.

In inefficient plants these differences are generally greater. The efficiency with oil firing as a rule suffers the least from unfavorable arrangements and careless operation. The table shows some examples which are not extreme and may be considered approximately representative. However, actual differences vary considerably from those shown, and it is necessary to investigate the reasons for inefficiency in each individual case before the effect of a change can be predicted. It may be well to insert a reminder here that powdered coal requires considerably more furnace space than other firing methods and that many conversions of small stoker installations to powdered coal have been disappointing.

EFFECT OF FUEL ON STEAM AND POWER CONSUMPTION

When considering steam consumption of fuel-oil heating apparatus it must be remembered that the chimney loss is figured from room temperature and consequently includes the heat actually imparted to the oil. Only the various losses involved in liberation and transfers of this heat are included in the tabulated figures for oil heating.

Tables 2 and 3 are intended to give an approximate idea of the magnitude of those items of steam and power consumption which may be affected by choice of fuel and firing method. The figures refer to reasonably efficient plants and may be more than doubled under careless operating conditions. They will also vary considerably with the size and design of equipment.

It will be seen from the tables that the only appreciable cost

TABLE 2 STEAM CONSUMPTION IN PER CENT OF TOTAL GENERATED

	Per cent
For oil heating (pressure atomizers)	0.4
For oil heating (other atomizers)	0.2
For steam atomizers	1.5–3
For steam-jet ash conveyer with powdered coal	0.15
With stoker-fired bituminous coal	0.25
With stoker-fired anthracite	0.4
For soot blowers with bituminous coal	0.6
For soot blowers with anthracite	0.4
For soot blowers with oil	0.3

TABLE 3 POWER CONSUMPTION IN KILOWATTHOURS PER MILLION BTU OF FUEL

	Kwhr per million Btu
For oil pumping and atomization	
With steam atomizers	0.02
With other atomizers	0.1
For coal pulverizer	0.5
For stoker	0.03
For forced draft	0.2–0.4
For coal conveyers	0.02
For refuse handling	0–0.02

differences between fuels and firing methods involve steam atomizers, coal pulverizers, and forced-draft fans.

Power for forced draft has to be considered in cases where it can be eliminated when changing from stoker to oil firing.

It is of interest to note that, with power at about 1.3 cents per kwhr, the power cost for pulverization cancels the advantage in efficiency of powdered-coal over stoker firing.

EFFECT OF FUEL ON REPAIR MATERIAL COSTS

Refractory costs depend primarily on furnace design and operation and may vary from a negligible amount to 0.5 cent or more per million Btu of fuel burned. Different coals often have a profound effect on refractory costs. However, under equivalent conditions of proper design and operation the difference in refractory costs between different fuels and firing methods should be negligible.

A fair average figure for repairs to stokers or pulverizers and coal- and ash-handling equipment may be around 0.15 to 0.2 cent per million Btu. It will vary considerably, depending primarily on operation and coal qualities. Repairs to bituminous-coal stokers average about the same as to pulverizers. Anthracite stoker repairs generally run lower, but on the other hand repairs to anthracite handling equipment run higher, so that the total is about the same as for bituminous coal.

Repairs to oil handling and firing equipment vary from a negligible amount to perhaps 0.05 cent per million Btu.

EFFECT OF FUEL ON LABOR REQUIREMENTS

Some years ago it was a common argument in favor of powdered coal that there was practically no refuse to handle as is the case with stoker firing. Nowadays, dust separators are compulsory for powdered-coal installations in most, if not all, of the New York area. The amount of refuse to handle is about three quarters of that for a stoker installation, and the labor required for handling is about the same as for the stoker-fired plant. An anthracite-burning plant has to handle about twice this amount of refuse. In some cases this may affect the pay roll, but with proper conveyer arrangements it does not. The labor involved in coal and refuse handling varies from about 0.25 to 1 cent or more per million Btu.

With oil firing this labor generally can be eliminated. One positive exception is the small stoker-fired plant operated by one man. But even in larger plants, where coal and refuse handlers have additional duties, it is often found impractical to take a man off the pay roll when changing from coal to oil. In most cases, however, the labor saving is a considerable item in favor of fuel oil.

Labor costs for repairs are roughly proportional to repair material costs and generally amount to less than material costs.

Differences in labor costs in plants using different fuels depend on individual conditions in each specific case and no general figures can be given. Since the minimum unit is one man's time, differences have to be determined first on a man-time basis and thereafter have to be refigured to a million-Btu basis if needed.

REFUSE DISPOSAL

The amount of dry refuse per million Btu of fuel burned averages roughly as follows:

For bituminous coal, powdered firing, lb	6
For bituminous coal, stoker firing, lb	8
For anthracite coal, stoker firing, lb	14

Anthracite cinders are used in various concrete products. Before the depression these cinders could be sold for 25 to 50 cents per ton at the plant. Due to the later condition of the building industry the best price now is free removal and ranges from there up to a charge of 50 cents per ton dry weight. This is equivalent to 0–0.35 cent per million Btu of fuel.

The cost for disposal of bituminous-coal cinders varies from free of charge to $1 per ton, which is equivalent to 0–0.4 cent per million Btu of fuel.

Powdered-coal ash is generally expensive to dispose of and costs range from 50 cents to more than $1 per ton. This is equivalent to 0.15–0.3 cent per million Btu of fuel.

INVESTMENT IN CHANGED AND NEW EQUIPMENT

This heading is inserted in order to complete the list of factors which must be considered, but a general discussion of it will not be attempted. It would be futile to establish average costs for conversion jobs due to the extreme variations in individual cases. A study of new plant designs and economics must be considered to be outside the scope of this paper.

CASE EXAMPLES

The significance of the figures given in this paper as well as eventual use of them may be clarified by a couple of specific examples. Table 4 refers to the case of a small plant in which a change-over from anthracite to oil is under consideration. The annual gross saving, based on past average oil cost, is of such magnitude that an installation to burn oil exclusively seems justified.

TABLE 4 COMPARISON OF ANNUAL FUEL REQUIREMENTS AND OPERATING EXPENSES FOR SMALL PLANT CONSIDERING CHANGE-OVER FROM ANTHRACITE TO OIL

	Anthracite	Oil
Steam output, million Btu	100,000	100,000
Efficiency, per cent	65	75
Fuel for steam output, million Btu	154,000	133,000
Fuel for heating and steam atomization of oil (3%), million Btu	...	4,000
Total fuel, million Btu	154,000	137,000
Fuel cost,[1] cents per million Btu	19	20
Fuel cost,[1] dollars per year	29,300	27,400
Electric power for forced draft, dollars per year	400	...
Additional labor with coal, dollars per year	1500	...
Additional repairs with coal, dollars per year	150	...
Refuse disposal, dollars per year	350	...
Total, dollars per year	31,700	27,400
Gross saving, dollars per year	...	4,300

[1] Present anthracite price; last 3 years' average oil price; truck delivery for both.

Table 5 illustrates one method of calculating the fuel-oil price limit for a large plant equipped to burn either powdered coal or oil.

TABLE 5 PRICE LIMIT FOR FUEL OIL IN A LARGE PLANT, EQUIPPED TO BURN EITHER POWDERED COAL OR OIL, CALCULATED ON A MILLION BTU BASIS

Annual fuel consumption, million Btu	2,000,000
Efficiency with coal, per cent	83
Efficiency with oil, per cent	84
Million Btu of oil equivalent to 1 million Btu of coal (83/84)	0.988
with allowance for additional steam consumption with oil	0.99
Cost of coal per million Btu, cents	16.0
Cost of additional power with coal (0.4 kwhr at 0.5 cent), cent	0.2
Cost of additional repairs with coal, cent	0.15
Cost of additional labor with coal ($4000/2,000,000), cent	0.2
Cost of refuse disposal, cent	0.15
Cost total, cents	16.7
Price limit for oil (16.7/0.99), cents	16.87

The author is indebted to the Marshall Coal Corporation and the Combustion Engineering Company for information contained in this paper.

Quick-Acting RELEASE LATCHES

By CARL THUMIM

GENERAL ELECTRIC COMPANY, PHILADELPHIA, PA.

THE circuit breaker is a very important link in the operation of systems for transmitting electric power. The reliability of the breaker depends a great deal upon its mechanism; in turn, the reliability of the mechanism depends upon its latch. Too little attention has been paid to rational considerations in the design, manufacture, and maintenance of a mechanism so vital to proper operation. In this paper it is the endeavor of the author to examine the underlying principles in order to present a view of the designer's intentions and of the difficulties to be overcome in obtaining satisfactory functioning.

LATCHES FOR CIRCUIT-BREAKER-OPERATING MECHANISMS

The operating mechanism consists of the power unit, Fig. 1, to provide the required closing force, the linkage which connects the power unit to the breaker, and the latch which keeps the breaker closed. Usually, in the nontrip-free mechanism, the latch has the dual function of holding the breaker in the closed position and of being the tripping means to allow the breaker to open. In the trip-free mechanism these functions are segregated, one latch being furnished to hold the breaker in the closed position and another for tripping. While the general characteristics are the same, the former need not be as sensitive or as shockproof as the latter, since it does not have to respond to a definite tripping impulse and does not have to withstand shocks encountered in closing.

The latch may be defined as a mechanical device which will hold securely under any set of predetermined conditions and which will release with equal reliability under another set of circumstances. For continuity of electric service it is necessary that the latch hold securely. When the breaker acts as a safety device, under conditions of stress, it is even more important that the latch open promptly. It can then be safely stated that the reliability of a breaker mechanism is synonymous with the reliability of its latch.

TYPES OF LATCHES

All latches can generally be divided into four classes:

Class 1, dead center
Class 2, overcenter toggle
Class 3, overcenter surface
Class 4, magnet

The Class 1 latch has several subclasses illustrated in Fig. 2. The best is shown in Fig. 2(a) where torque caused by the force of spring *A* acting against lever *B* pivoted on *C* is resisted by support of prop *D* against roller *E*. As the two coacting surfaces are perfectly circular with their respective pivot points *F* and *G* at the center, the line of force goes through the point of tangency and through the exact centers of *F* and G. There is, therefore, no moment to cause rotation around *F* or *G* and the latch is in stable equilibrium.

To trip, coil *J* is energized and its plunger strikes *D* and removes the obstruction to the rotation of *B*. After tripping, when *B* is returned to the starting position by some other member of the mechanism of which it is a part, spring *K* returns *D* to its locking position.

Fig. 2(b) shows the same principle with hook *M* taking the place of prop *D*. While the method of action is identical the true radial surface *L* is more difficult to obtain on *M* than on *D*.

A simplified version is illustrated in Fig. 2(c), which can be used where the forces are small. The prop consists of shaft *L* with the middle section cut away to permit lever *B* to trip when coil *J* has rotated *L* counterclockwise.

The Class 1 latch is known as the dead-center type, for the restrained force of spring *A* has no resulting moment which would cause the latch *D* to rotate, a lack of effect typical of any dead-center mechanical construction. Ordinarily, the dead-center position is a point or a narrow band having a zero moment on either side of which there is an effective turning moment. In the Class 1 design, this band can be made as wide as desired. For example, in Fig. 2(a) the dead-center action persists for the rotation of prop *D* through the angle ϕ. There is no tendency for *B* to move until the end of the latch surface has passed the center line *H*.

The second class of latch consists of the overcenter toggles, illustrated in Fig. 3. There are two schemes generally used, compression or tension, as shown by Figs. 3(a) and 3(b). In Fig. 3(a), the spring *A* tends to turn lever *B* counterclockwise around pivot *C*. This movement is restrained by toggle links *E* and *D* locked against stop *M*. The nominal amount of overcenter is indicated by *P*, the distance from the line *H* between pins *F* and *G* to the center of pin *L*. To trip, coil *J* is energized and drives the toggle over center, i.e., pin *L* moves more than the distance *P*. The toggle then collapses and removes opposition to the motion of *B*. During this action, i.e., until pin *L* reached center line *H*, *B* was being rotated clockwise, and trip coil *J* was used to compress spring *A*. To reset, *B* is pulled into stretched-toggle position by a part of the mechanism not shown and the toggle is driven to the locked position by spring *K*.

The action in Fig. 3(b) is the same as that in 3(a) except that link *D* is in tension.

The third classification of latches consists of the overcenter surface type and depends for latching characteristics on the configuration of a surface. It is used more than any of the other types, especially in other than the electric apparatus field, probably because it may be adjusted to give "hair-trigger" action. In Fig. 4 are illustrated three common forms of this class. In Fig. 4(a) the force of spring *A* on lever *B* is resisted by prop *D*. The slope of surface *L* determines the direction of the force *H*. The distance *P*, between this force and the center of *G*, is the moment arm which, with the force *H*, provides the moment to hold the latch locked against

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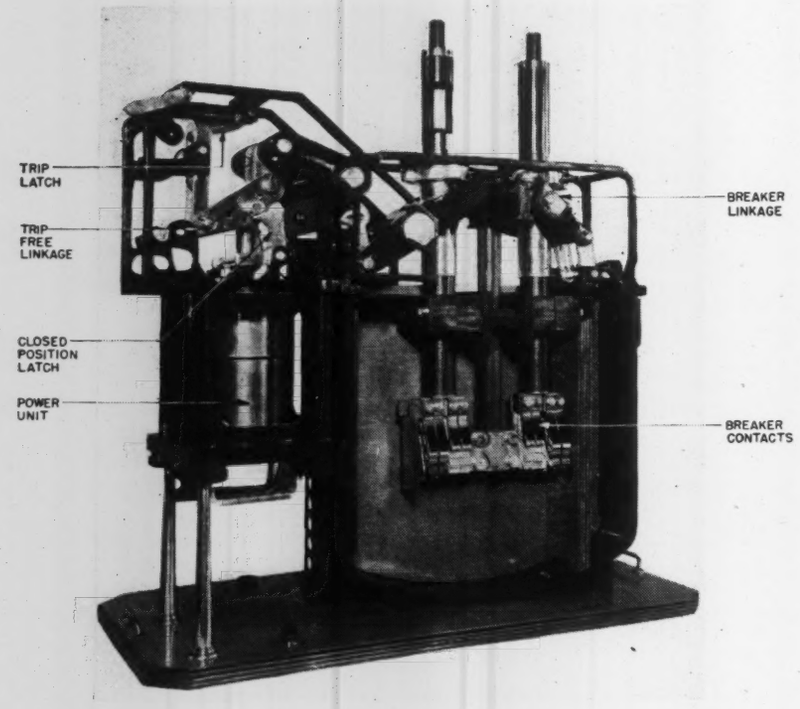


FIG. 1 CUTAWAY VIEW OF TYPICAL OIL CIRCUIT BREAKER AND MECHANISM

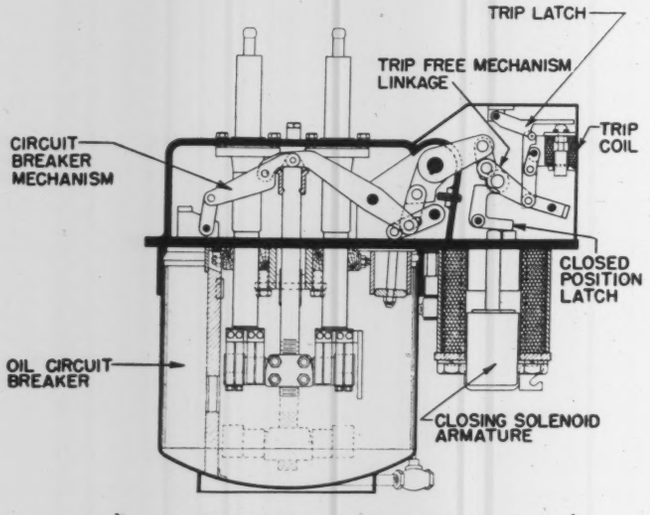


FIG. 1*a* DRAWING OF MECHANISM SHOWN IN FIG. 1

stop *M*. The greater the distance *P*, the greater the locking torque and therefore the greater the force trip *J* must exert to unlock the latch. *P* may be reduced to zero or almost zero so that only a slight force is needed at *J* and hair-trigger action results. With such accurate adjustment, it requires very little motion of *D*, resulting from vibration or from shock, to unlatch. Likewise, wear may change the direction of *H* so that *P* falls on the other side of *G* and the locking effect will entirely disappear.

The latch in Fig. 4(b) is identical with that of 4(a), except that surface *L* is part of lever *B*. In Fig. 4(c) is illustrated another very common latch of the hook type, in principle the same as 4(a). Variant in 4(d) is 4(b) with a roller replacing the sliding point. This latch reduces tripping force, requires more motion of the trigger to release, and is different from the one in Fig. 2(a), in that it depends on locking torque arm *P*, whereas the 2(a) latch needs no locking torque.

The fourth class of latch depends on magnetic force for the locking characteristic. The usage as a latch, shown in Fig. 5, is limited but it is employed more to provide tripping force in conjunction with one of the other mechanical latches, where its extreme speed gives it an advantage. In Fig. 5(a) is shown the simplest type of magnetic latch. The force of spring *A* on lever *B* is resisted by the pull of electromagnet *L* on armature *E*, which is pivotally fastened to *B*. To maintain the force on *E*, the coil *J* must be continuously energized. To trip, the circuit to *J* is broken and *E* released. The time of tripping can be reduced to a minimum by the so-called "flux-shifting" type in Fig. 5(b). *M* may be a permanent or electromagnet with laminated pole pieces *L* proportioned to supply the maximum attracting force to laminated armature *E*. Trip coil *J* is wound around a laminated core *D* placed between the pole pieces *L* with definite gaps *P*. When latched, the flux circuit is shown in 5(c), the reluctance of the iron being so much less than that of the air gaps *P* that practically all the flux lines go through *E*. When *J* is energized to trip, Fig. 5(d), the reluctance of the air gaps is reduced so that the flux from *M* passes through *D* instead of through *E* and the flux through *E* is reversed, thus causing *E* to move away as soon as the holding torque becomes smaller than the load torque resulting from the action of *A*. With proper proportioning, appreciable movement of *E* can be obtained 0.001 sec after the circuit through *J* is completed.

QUANTITATIVE COMPARISON

To obtain a more comprehensive picture of the characteristics of the first three latch classes, force analyses of typical designs under various conditions are presented.

The quality of a latch is often indicated by its behavior under ideal conditions which may be interpreted to mean friction coefficients and locking torques equal to zero. Fig. 6 shows the three classes of latches under these circumstances. Since Fig. 6(a) is a Class 1 latch, the locking torque is inherently zero. The Class 2 latch of 6(b) must be placed on dead center to eliminate locking torque. In the Class 3 latch of Fig. 6(c), the surface *L* must be so directed that *H* goes through the center of pin *G*. Under these circumstances and with zero friction, the tripping forces *J* are zero. The torque of restoring spring *K*, small in proportion to the other forces, has been neglected. Of the three latches, only 6(a) is in stable equilibrium, a large motion of *D* having no effect, while slight changes in the other two would either unlock them or lock them with a torque of unknown magnitude.

Since, under the circumstances described, two of the three latches are unstable, an analysis is now made of their behavior when all are positively locked, with the same amount of motion at *J* to unlatch. This distance may be considered the measure of shockproofness. Zero friction is assumed. Fig. 7 shows the three classes under the given conditions with their respective force diagrams immediately below them. Assuming force at *A* equal to 100, the Class 1 latch at 7(a) carries load of 40 lb *H*, obtained from diagram 7(b). Since there is no locking torque around pin *G*, and friction is absent, the force at *J* is zero. Taking the same *H* load on the Class 2 latch in Fig. 7(c), we obtain from the diagram 7(d) a value of 5 lb for *J*. Again using the same value of *H* for the Class 3 latch of Fig. 7(e), the value of 2.5 lb is obtained for *J*. Under these conditions of

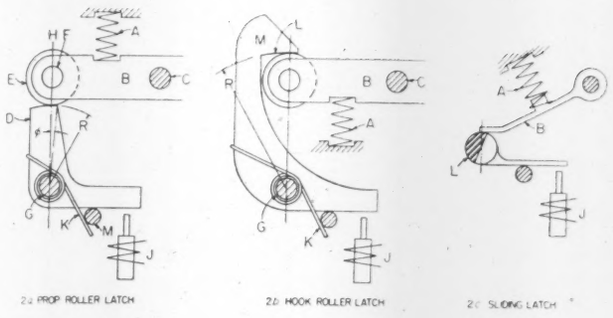


FIG. 2 CLASS 1, DEAD-CENTER LATCH TYPES

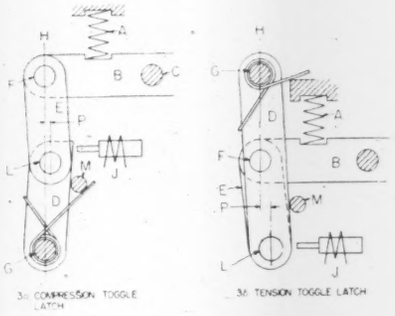


FIG. 3 CLASS 2, OVERCENTER TOGGLE LATCHES

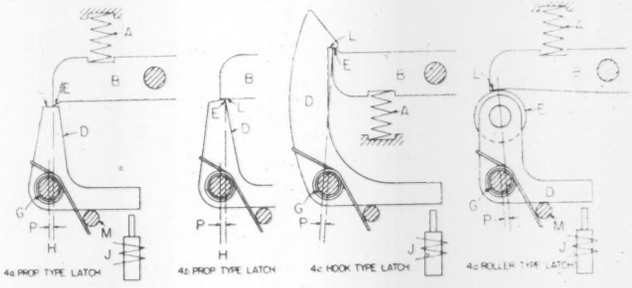


FIG. 4 CLASS 3, OVERCENTER SURFACE LATCHES

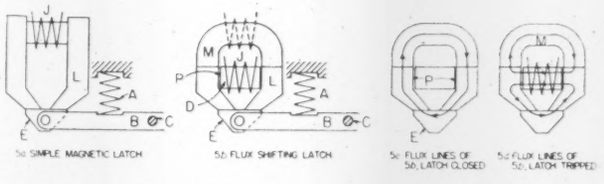


FIG. 5 CLASS 4, MAGNETIC LATCH

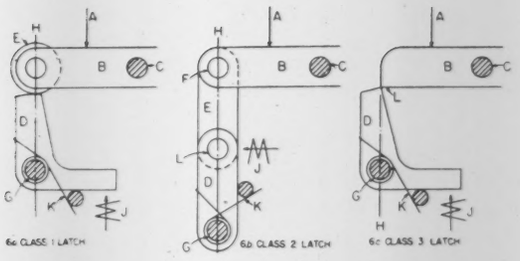


FIG. 6 LATCHES UNDER IDEAL CONDITIONS
(Coefficient of friction = 0; locking torque = 0.)

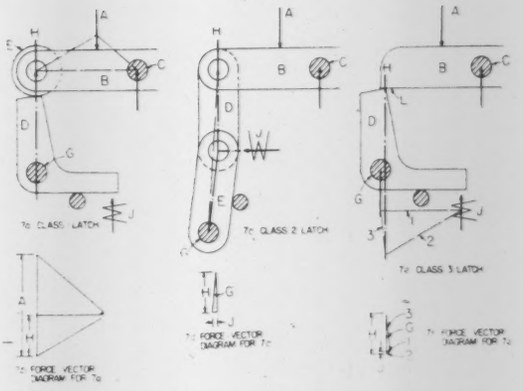

7a CLASS 1 LATCH
7c CLASS 2 LATCH
7e CLASS 3 LATCH
7b FORCE VECTOR DIAGRAM FOR 7a
7d FORCE VECTOR DIAGRAM FOR 7c
7f FORCE VECTOR DIAGRAM FOR 7e

FIG. 7 LATCH COMPARISON FOR EQUAL TRIP DISTANCE
(Coefficient of friction = 0.)

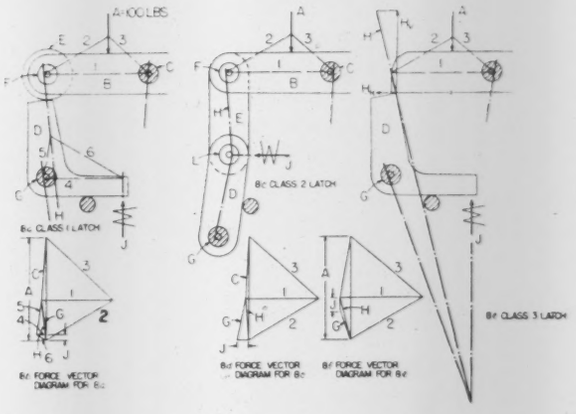

A-IDOLES
8a CLASS 1 LATCH
8c CLASS 2 LATCH
8e CLASS 3 LATCH
8b FORCE VECTOR DIAGRAM FOR 8a
8d FORCE VECTOR DIAGRAM FOR 8c
8f FORCE VECTOR DIAGRAM FOR 8e

FIG. 8 LATCH COMPARISON UNDER NORMAL CONDITIONS
(Coefficient of friction = 0.25.)

equal shockproofness, the Class 1 latch has the least tripping force, the Class 3 the next larger, and the Class 2 the largest. The geometry of the 7(c) and 7(e) latches indicates that, during the unlatching process, lever *B* is turned clockwise and the energy obtained from *J* closes the mechanism very slightly in addition to its opening function. This condition is hazardous, as an unexpected rise in the resistance of *B* may stall *J* and keep the latch locked. The Class 3 latch is particularly vulnerable for any irregularity in the surface *L*, due to wear for example, may cause the latch to stick.

Friction must be considered in determining the functioning of a practical latch. The rolling friction between hardened surfaces is small and may be neglected. Sliding friction, however, has been found to approach the figure of 25 per cent which will be used in all analyses. It is understood that the result of the friction study fixes a limit within which the latch must function properly. The other limit is zero friction which may be approached or even obtained under some conditions of lubrication or vibration. The latch must operate satisfactorily under a wide range of conditions delineated by the two friction limits and by inaccuracies due to manufacture and wear. Fig. 8 illustrates the three classes of latches having the same proportions as those of Fig. 7, but analyzed with friction.

In the Class 1 latch of Fig. 8(a), the pins *F* and *G* are shown with friction circles, the force *H* being tangent to the friction circle of *F* and passing through the point of contact between *E* and *D*. Since *B* does not move during the unlatching process, friction at *C* need not be considered. The combined vector diagram 8(b) gives 39 lb for *H* and 5.5 lb for *J*. Fig. 8(c) shows the Class 2 latch with all pins, including *C*, analyzed for friction, since all parts move during unlatching. Due to this, *H* is larger, which eventually means a larger tripping force.

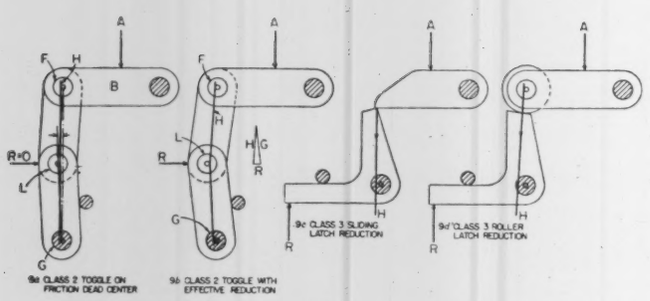

9a CLASS 2 TOGGLE ON FRICTION DEAD CENTER
9b CLASS 2 TOGGLE WITH EFFECTIVE REDUCTION
9c CLASS 3 SLIDING LATCH REDUCTION
9d CLASS 3 ROLLER LATCH REDUCTION

FIG. 9 LATCHES AS FORCE-REDUCTION LINKAGES

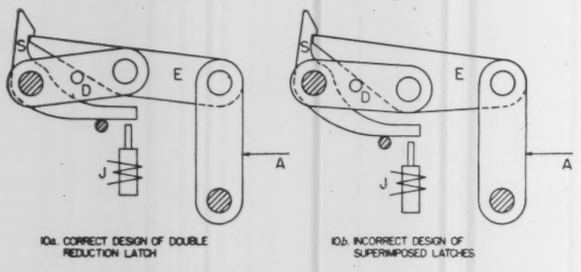


FIG. 10 DOUBLE-REDUCTION LATCHES

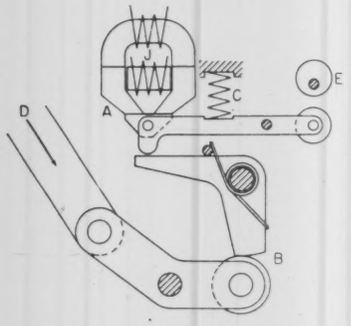


FIG. 11 CLASS 4 LATCH USED TO SUPPLY TRIPPING FORCE

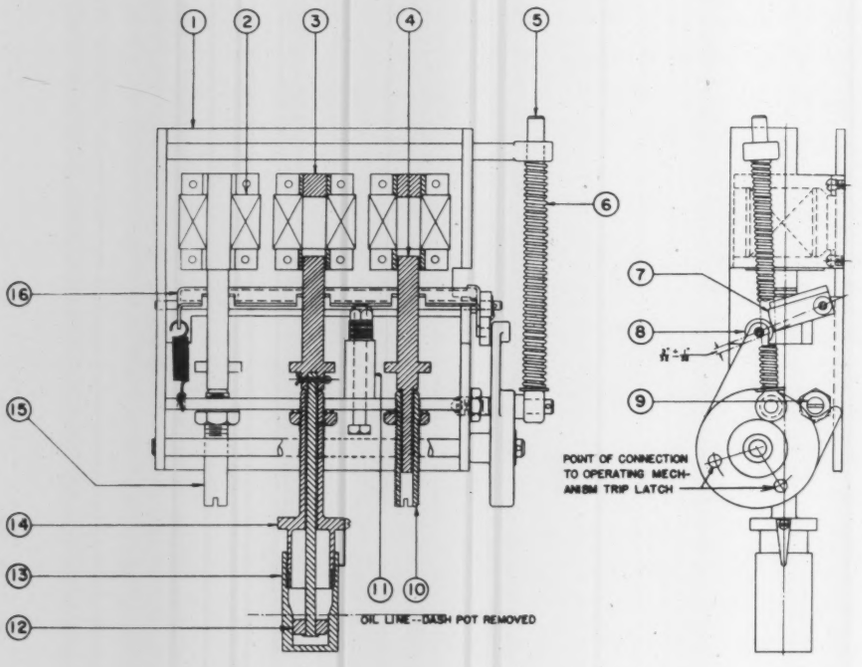
Fig. 8(d) indicates 40 lb for H and 11 lb for J. In the Class 3 latch of Fig. 8(e), H is the resultant of the vertical support H_V acting on lever B and a horizontal force H_H numerically equal to 25 per cent of H_V. From the corresponding force diagram 8(f) H and J are 42 and 14 lb, respectively.

TABLE 1 VALUES OF TRIPPING FORCES (LB)

Condition				
Friction, per cent	Locking torque	Class 1	Class 2	Class 3
0	0	0	0	0
0	normal	0	5	2.5
25	normal	5.5	11	14

A summary of the tripping forces in Table 1 indicates that, under service conditions, the Class 1 latch requires the least tripping force and the Class 3 the most. It is desirable, especially in large mechanisms, to reduce the tripping resistance to obtain the maximum acceleration from the available tripping energy. One way to do this is to reduce the friction component, which may be done by using antifriction bearings. The best results are obtained from the Class 1 latch where the roller is large enough to accommodate a ball bearing and the pin G, Fig. 8(a), rotates in stationary bearings. In the Class 2 latch, the links would have to be materially enlarged and the gain would be partly counterbalanced by the force necessary to accelerate the increased mass. In the Class 3 latch, antifriction bearings give no advantage unless the Fig. 4(d) scheme is used and here the mass would be increased. In this design the number of parts is identical with that of the Class 1, Fig. 2(a) latch, but machining is more difficult and results are less satisfactory. It is difficult to understand why it is ever used.

A study of the tripping forces indicates that a latch is a force-reducing device, since the tripping force is always smaller than the loading force. It is possible then, to change the proportions so that instead of a small locking torque there is a small tripping torque for use as part of a linkage to obtain mechanical advantage. This does not apply to the Class 1 latch which has no locking torque and therefore cannot have any tripping torque. Fig. 9 illustrates the use of the latches as force-reduction units. In Fig. 9(a) the toggle is so arranged that the line



1 Frame
2 Coil
3 Magnet Frame
4 Armature
5 Eyebolt
6 Tripping Spring
7 Latch
8 Roller
9 Stop
10 Calibrating Screw
11 Buffer Stop
12 Piston
13 Dash Pot
14 Inverse Time Delay Device
15 Instantaneous Trip Device
16 Trip Pan

FIG. 12 IMPACT TRIP MECHANISM

H is tangent to the 25 per cent friction circles so that the value of the resultant *R* is zero although the pins have an ostensible offset of *P*. To obtain a positive value for *R*, the nominal offset must be increased as shown in 9(b) so that line *H*, extended, falls definitely to the left of the *G* friction circle. The exact value of *R* cannot be known, due to the uncertainty regarding the coefficient of friction, but should be considered to lie in a belt between the minimum friction equal to zero and the maximum which may approach 25 per cent. In Figs. 9(c) and 9(d) are two forms of the Class 3 latch used as force-reduction units. To obtain the proper direction of line *H* the surface *L* must be correctly sloped and is usually obtained by a costly assembly fitting operation. This is an added uncertainty in the Class 3 reduction not present in the Class 2 reduction.

The use of the toggle as a reduction unit is shown in Fig. 10(a) where the force of spring *A* is reduced by links *E* and *D* before latch *S* is applied. Trip coil *J* first unlatches *S* and then applies force against *E* if the toggle tends to stick. In contrast to this construction is shown the double latch Fig. 10(b) where there is a Class 3 latch superimposed on a Class 2 latch both in the locked position, in the hope that the combination will be more shockproof than either used alone. This is an expensive design and probably not as reliable as the Class 1 latch.

The force analysis of the Class 4 latch is simple and need not be explained in detail. Referring to Fig. 5 the available magnetic force at the armature *E* should be about twice as much as is really needed to oppose the torque of load *A* in order to obtain adequate shockproofness. This is necessary as the magnetic force on *E* drops very rapidly as *E* moves away from the pole pieces, a vibrating movement sure to occur during the operation of the mechanism. The loading force has for simplicity been shown as a spring. In the actual mechanism, however, it is the resultant of a number of forces, such as the breaker reaction, accelerating-spring forces, and closing force, and varies throughout the stroke and with each operation. Where a mechanical latch is used, the variable loading is simply reflected in a similarly varying tripping resistance and, as long as the maximum tripping force is not exceeded, the apparatus will function. Shock loads have no effect on the action. If the magnetic latch were used directly connected with the linkage, the ratio of magnetic to loading forces would have to be 2 to 1, taking the shock loads as a base. For normal loads, this ratio would therefore be much larger so that more flux would have to be moved and the great speed advantage of the design lost. To retain this feature and obtain stability, it is customary to load the magnetic latch with a spring and then to use it to apply tripping force to a mechanical latch having satisfactory shock resistance. In Fig. 11, *A* is the magnetic latch loaded by spring *C; B* is the Class 1 latch loaded by the mechanism at *D* and released by impact of the magnetic-latch lever when coil *J* is energized, *E* is a cam driven by the mechanism to reset *A* after tripping.

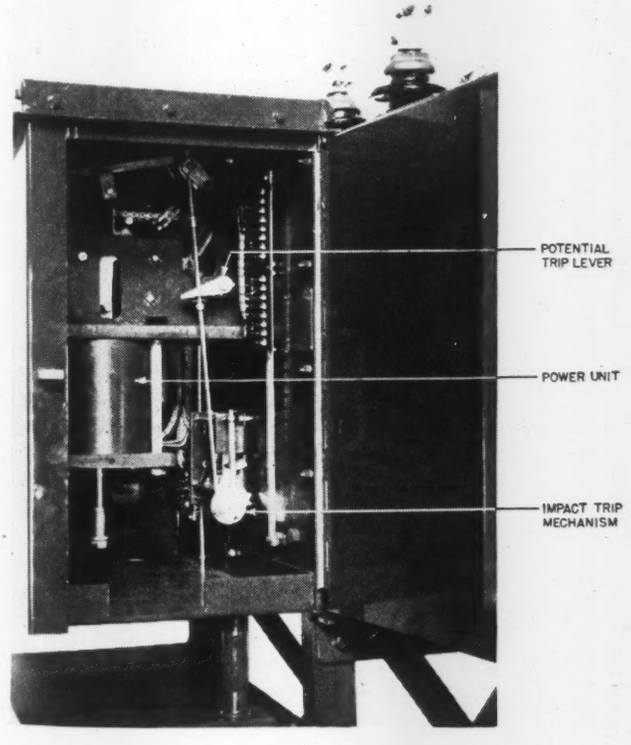


FIG. 13 IMPACT TRIP DEVICE APPLIED TO CIRCUIT-BREAKER MECHANISM

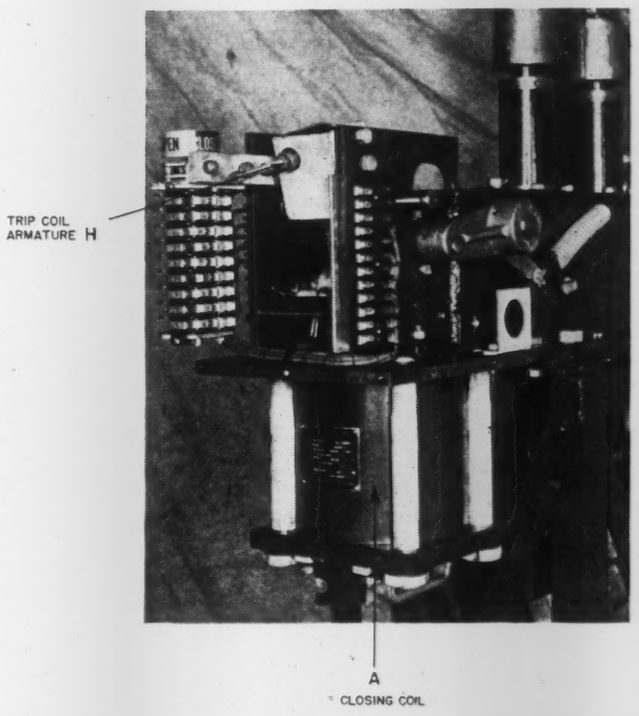


FIG. 14 SHOCKPROOF TRIP-COIL LOCATION IN OPERATING MECHANISM

Another instance of the use of a definite spring load on a latch is the impact current trip device. The available tripping energy is small, usually obtained directly from a current transformer of low rating. If large breaker forces were mechanically reduced to a point where this small trip force would be sufficient, there would always be danger that the load on the latch could entirely disappear due to excessive friction. If the proportions were so made that large friction coefficients were taken care of, loss of this friction, as in excessive lubrication, would make the force on the latch too great. If, however, the reduction is carried to the point where the standard potential trip is satisfactory, and a separate device consisting of a spring-loaded latch, proportioned for a light tripping force is supplied for tripping by impact, the result is apt to be more reliable and satisfactory. Fig. 12 shows an impact tripping device for current trips and Fig. 13 illustrates its application to a mechanism.

The most common method of obtaining tripping force is by means of an ironclad solenoid of the plunger and pole-piece

type. Excess force must be available for speed. A small space provided between the plunger and the latch trip finger gives impact which jars loose parts that may bind and results in more reliable operation, especially in the low-voltage range. In all mechanisms there is one direction in which the shock is maximum. In a solenoid mechanism the shock is greatest when the armature hits the pole piece and tends to accelerate all loose parts touching the frame in the direction of the motion of the armature. The trip solenoid plunger must be so located that this acceleration will not drive it against the latch. By placing the line of the tripping motion substantially at right angles to the line of the shock force, susceptibility to shock is reduced. Referring to Fig. 14 the closing force moves in the direction of arrow *A*, thereby causing shock forces in the same direction. Due to placing of trip plunger *H* horizontally, these shock forces have a tendency to drive it against the sides of the trip coil with no resultant to move the plunger against the trip latch.

Another method of obtaining trip force, especially in smaller mechanisms, is by thermal release. The forces generally are small and shock is nonexistent so that the Class 3 latch is satisfactory. Fig 15 shows two variations, in the first of which,

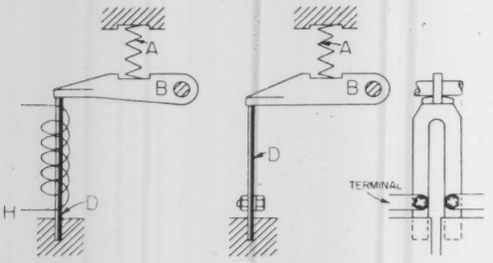


FIG. 15 THERMAL TRIP USED WITH CLASS 3 LATCH

15(a), the bimetal strip *D* is heated by a resistance coil *H* and bends to the left to remove its support from lever *B*. In the second, 15(b), the bimetal strip is part of the current path and the heating caused by its resistance causes the flexing necessary to trip.

In describing the performance characteristics of the latches, some mention was made of practical considerations. Several of these will be taken up in more detail. One of the important points is the ease of manufacture. In the Class 1 latch, the important surfaces of the roller and the prop are perfectly circular and can be produced economically. The location of the pivot centers does not materially affect the reduction or the locking properties, so that small variations due to manufacture or wear are not of critical importance. As the coacting surfaces are hard and subject to the effect of rolling friction only, wear is negligible. In the Class 2 latch, the amount of overcenter is a major consideration and is often made adjustable. The main toggle parts are subject to sliding friction which, in conjunction with the changes due to hammering of the toggle stop, makes the latch change in service. Of the mechanical latches, the Class 3 is the most sensitive to manufacturing variations, since the slightest change in center distances and contour of acting surfaces makes a large difference in latching constants. Indeed, these difficulties are such that the final shape of latch surfaces is usually left to assembly. After the proper angles are determined by test and the parts ground to shape, a hardening operation follows which cannot be as complete or reliable as when parts are hardened in the ordinary course of manufacture and makes the latch more susceptible to wear. Sometimes, the hardening alters the form and additional honing is needed to obtain satisfactory operation. During unlatching, the action consists of a line rubbing across a surface, resulting in wear.

TABLE 2 NUMERAL EVALUATION

Performance characteristics	Class 1	Class 2	Class 3	Class 4 plus Class 1
Reliability	3	2	1	2
Shockproofness	4	2	1	3
Sensitivity	2	1	3	4
Speed	2	1	2	4
Practical considerations				
Ease of manufacture	4	3	1	2
Wear	3	2	1	3
Need for adjustment	4	2	1	3
Cost advantage	3	4	2	1
Composite rating	25	17	12	22

If ordinal values are assigned to the various characteristics, with the greater number of points for the higher quality, the ranking is shown in Table 2. There is no attempt in this tabulation to weigh the comparative importance of the various factors. In smaller mechanisms, where all forces are low, shock forces may be of a magnitude which make the use of a Class 3 latch perfectly satisfactory. In such mechanisms, the need for great reduction of forces may likewise be unnecessary and wear negligible. As the size of mechanism increases, both the performance and construction considerations become more important, and the use of the Class 1 latch is indicated. Here again, other considerations, such as extreme speed, may be of paramount importance, in which case it may be necessary to use the Class 1 latch for mechanical reasons in combination with a Class 4 latch to supply the tripping force.

The Place of the Diesel Engine in Our National Defense

(*Continued from page 803*)

beacons and beams, and tractors, the Diesel is superior to other types of engines.

For trucks the use of the Diesel is still limited. In this respect, may I quote from a talk by R. K. Evans, vice-president of the General Motors Corporation, in charge of Diesel development: "But in dealing with this particular subject, I believe that there are more than the usual reasons for viewing the future with conservatism and caution. Too much publicity has already been given to predictions as to revolutionary changes which Diesel engines are going to bring in all fields of power. Unless a more conservative attitude is adopted there is a likelihood that the public will be sadly disappointed with the eventual actual accomplishments."

For aircraft, light automobiles, and our combat vehicles, satisfactory Diesels have not yet been developed. I sincerely believe that with more research in the use of the newer alloys a great advance will be made in the solution of this problem. Some of these have the properties of resisting fatigue at high temperatures.

The two-cycle principle of operation is a field offering many advantages for the use of a light, high-speed Diesel engine.

Finally, in the matter of Diesel fuels there is still a chance for development. The higher the speed of the Diesel engine the more sensitive it is to fuel changes. The ignition lag which causes knock in Diesel engines depends, in addition to other factors, upon the nature of the fuel.

I am optimistic enough to think that within the next decade there will be available light, high-speed Diesels for our aircraft and combat vehicles.

A New Method of MACHINE-TOOL-SPINDLE ANALYSIS

By THOMAS BARISH

ASSISTANT CHIEF ENGINEER, MARLIN ROCKWELL CORPORATION, JAMESTOWN, N. Y.

A WELL-KNOWN type of surface grinder is regularly manufactured with the motor mounted directly on the spindle, Fig. 1, resulting in a fairly long spindle but of liberal diameter. About four years ago, a group of large heavy-duty grinders was ordered with independent motor drives specified, the motors to be directly coupled to a short wheel spindle, Fig. 2. The over-all height then became large. The author was asked to predetermine how much this spindle might be shortened without any material loss in rigidity or even, if possible, provide an increase in stiffness. The following analysis resulted:

The two major deflections were in the spindle and in the bearings, the wheel holder and housing being large enough to make their yielding negligible. The shaft deflections were calculated by the usual beam formulas, assuming the beam perfectly rigid below the lower bearing. The ball-bearing deflections were obtained by applying the well-known Hertz theory, allowance being made for the proper preloading.

The deflections were determined as the amount of yield at the point of cutting or load application, *A*, Fig. 2. A 2500-lb load was selected for the calculations because the head itself weighed close to that; a simple check could be made on the machine, subsequently, by dropping the head onto the base and measuring the deflection with suitably placed indicators.

On this basis, the deflections of bearings and spindle were calculated repeatedly for various bearing-center-line distances and summarized in curves, Fig. 3. The 2500-lb load seemed high and might give misleading comparisons so the calculations were repeated for 500 lb.

As expected, the deflections due to spindle flexibility increased with larger center-line distances and the effect of bearing yield fell off. At very short centers the bearing deflections are predominant and, at very long centers, the spindle deflections are excessive. The combined curve shows a gradual dip or optimum range. The allowable minimum distance between bearings was then selected as about 15 in., where the curve of total deflections began to flatten out.

After the machines were built, the deflections at the load point *A* were measured. They checked quite satisfactorily to within about 5 per cent of the calculated values.

GENERAL METHOD OF COMPARISON

During the succeeding years, this same method has been extended considerably for the purpose of comparing the rigidity of old spindle designs with new proposals and for comparing various new proposals, thus taking much of the guesswork out of a difficult problem. This new method has proved especially valuable in comparing the three different types of spindle-bearing mountings:[1] (1) Two single-row bearings (at each end); or (2) a three-bearing mounting with two together at the nose; or (3) with these two spread. For this last case, the calculations indicate how far to spread the two bearings. The method has also served to accentuate a movement toward shorter, larger spindles, and simpler designs.

The principle, upon which such design analyses must be based, is as follows:

The total maximum deflections of spindle, bearings, and frame under the expected loads shall be less than the smallest allowable depth of chatter mark.

The expected loads consist primarily of cutting or grinding pressures (and unbalance at high speeds). Actually, the variations in cutting or grinding pressures should control, but these variations can be considered as equal to the full pressures because the load readily drops to 0, even under the slightest tendency to chatter. There is little value in discussing the size of this load because practically every machine tool must accommodate widely varying conditions. Hence, for each case, an arbitrary load is selected and a location approximating the range of conditions under which the machine must do its best work. For that reason any calculation can only be comparative, a means of determining relative values of various design factors under an arbitrarily selected load condition.

Sometimes two widely differing ranges of operation are indicated. For example, horizontal boring mills are expected to provide good finish under very heavy milling-cutter work at slow speeds with small overhang and the cutter mounted directly on the spindle. The same machine with boring-bar work must handle considerably lighter loads at much higher speeds with a single cutting point. Then design checks should be made at both ranges for arriving at a satisfactory compromise.

The author has had occasion to analyze many different spindles by this method. Following are given two typical examples showing the details and the conclusions reached.

TWO-BEARING SPINDLE

The first example is a simple two-bearing heavy-duty shaft for a multiple-spindle automatic. The spindle size and maximum outside diameters are definitely limited by the machine size and the clearance between the spindles. The bore size must be kept as large as possible to permit handling the maximum possible stock size. There results a relatively large-diameter hollow spindle of unusual rigidity. On the other hand the center-line distance between bearings is relatively short.

The loading condition for analysis of the current design was

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[1] "Ball-Bearing Machine-Tool Spindles," by Thomas Barish, Trans. A.S.M.E., vol. 49–50, 1927–1928, paper MSP-50-10.

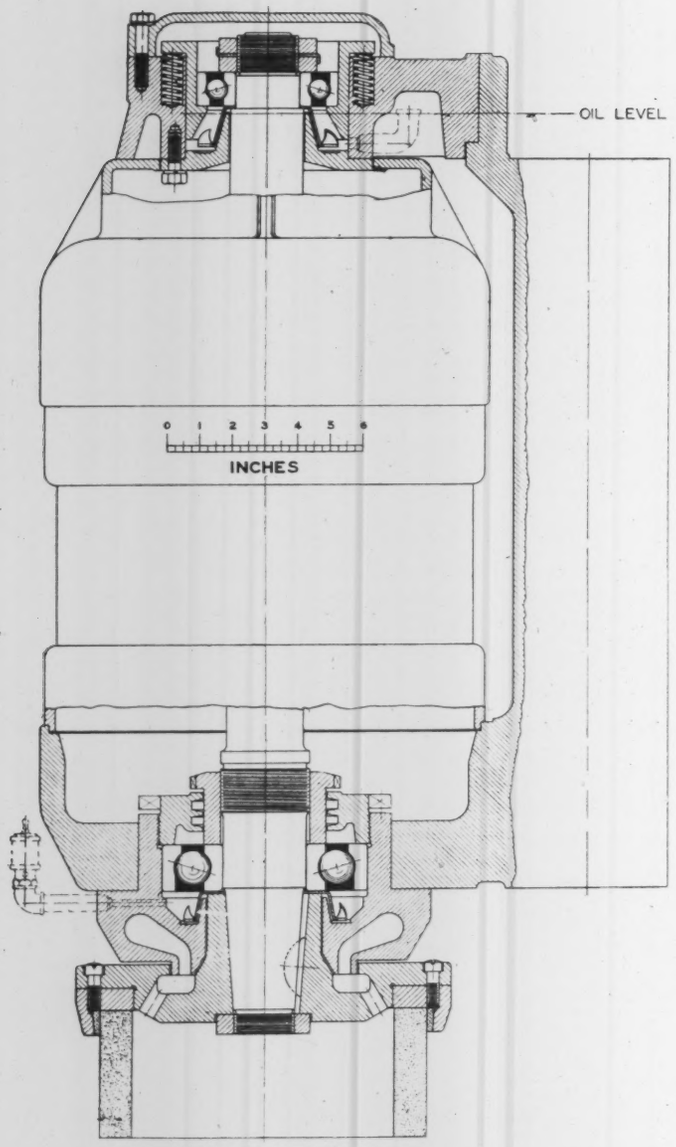


FIG. 1 TYPE OF SURFACE GRINDER HAVING MOTOR MOUNTED DIRECTLY ON SPINDLE; SPINDLE LONG BUT OF LIBERAL DIAMETER

taken near the maximum, i.e., 2000 lb load, overhung $9^1/_2$ in. The resulting deflections of the two bearings and of the shaft are shown independently and totaled in Fig. 4. The top curve represents shaft deflection only. In view of the very heavy checks and spindle noses, the part of the spindle from the front bearing to the work is assumed to have no deflection. The angularity or tilt of the shaft at the front bearing is extended as a straight line or tangent. Next below are the two curves showing independently the effect of each bearing, with proper allowance being made for preloading.

The double-row bearing at the nose is treated as a single bearing. Normally a pair of bearings, mounted back to back or a reversed-angle double row, will resist angular deflection of the shaft. However, in this case the short spindle permits so little angularity (0.0019 in. in $9^1/_2$ in.) that this stiffening effect is negligible. The fourth or bottom curve represents the total deflection of all three elements. Certain immediate conclusions affecting possible redesign for increased rigidity, may be drawn as follows:

1 With such short bearing-center-line distance, the shaft deflections are the least important element of the three.

2 The distance between bearings is the largest single factor, and particularly the nose bearing should be moved as close to the work as possible, every $^1/_{16}$ in. being valuable.

3 Both bearing deflections are relatively large, and particularly the tail bearing shows more effect than usual.

This analysis indicated that a material improvement could be obtained by very simple changes shown in Fig. 5, with the predicted effect on deflections. The use of two bearings in parallel at either end of the spindle, heavily preloaded against each other, largely eliminated the effect of the tail bearing, and slightly reduced the nose-bearing deflections. The net result was a total deflection of 0.0048 in. instead of 0.0074 in. In addition the use of two bearings in parallel cuts axial deflections under thrust load approximately in half.

No attempt was made to show what could be gained by moving the nose bearing toward the work, because this improvement depended upon machine limitations but nevertheless was very important.

THREE-BEARING MOUNTINGS

A well-known type of oscillating-race grinder was selected as an example because the hearty cooperation of the machine manufacturer permitted a complete and thorough analysis with positive results. It was thought that a complete new machine delivered about two years ago might do better work under very heavy cuts and a rigidity checkup was undertaken. Fig. 6 shows the test arrangement for comparing the rigidity of the various parts of the machine. The work head and grind wheel

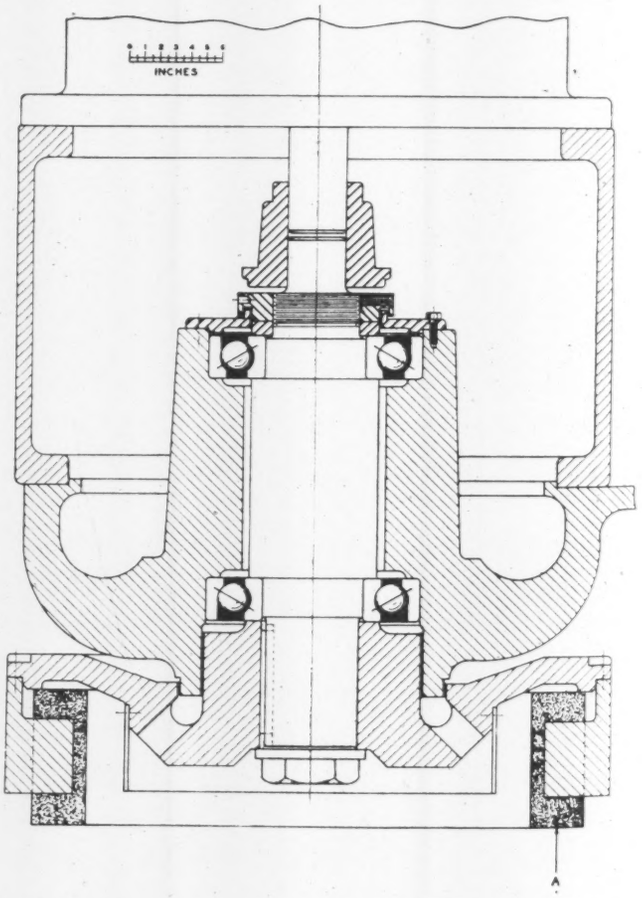


FIG. 2 HEAVY-DUTY GRINDER WITH MOTOR DIRECT-COUPLED TO SHORT WHEEL SPINDLE

were forced apart by a lever-and-spring balance with varying loads up to 200 lb. Deflection readings were taken (1) from the spindle (at point of carrying work) to the bearing housing, (2) from the spindle housing to the frame, (3) across the frame to the wheel-spindle housing, (4) from the wheel-spindle housing to the wheel and, of course, (5) the total from wheel to work.

Summary	Deflections under 200-lb load
(*a*) Total (from wheel to work)	0.00132 in.
(*b*) Work spindle and bearings	0.00074 in.
(*c*) Wheel spindle and bearings	0.00011 in.
(*d*) Remainder of machine:	
Frames and oscillating support	0.00047 in.

These measurements indicate a definite possibility of bettering the work-spindle and bearing mounting, and this part of the machine was then checked for deflections.

Fig. 7 shows the original work head and deflection curves, indicating the method developed for general use on three-bearing spindles. In this analysis, the two bearings at the pulley end were considered to act as if they were close together or equivalent to one bearing.

Curves 1 and 2 of Fig. 7 represent the deflections that would occur in the front ball bearing and in the rear pair, if the third or center bearing were not present. Curve 3 shows the shaft deflection on the same basis, i.e., a standard two-bearing mounting. The effect of the third or center bearing in stiffening the shaft was approximated by assuming that it pulled the shaft into center line at this point. Without a third bearing, the shaft would have been raised at this point (2.3 in. back from the front bearing) 0.00031 in. due to shaft yield; 0.00004 in. due to tail bearing; less 0.00012 in. due to nose bearing; or 0.00023 in. total. The center bearing, if it were then added, would impose enough load to bend the shaft downward at this point by an amount of 0.00023 in. (less the deflection in the center bearing itself). Curve 4 indicates this reverse deflection or "stiffening" of the shaft. Adding the four curves gives the total deflection, curve 5.

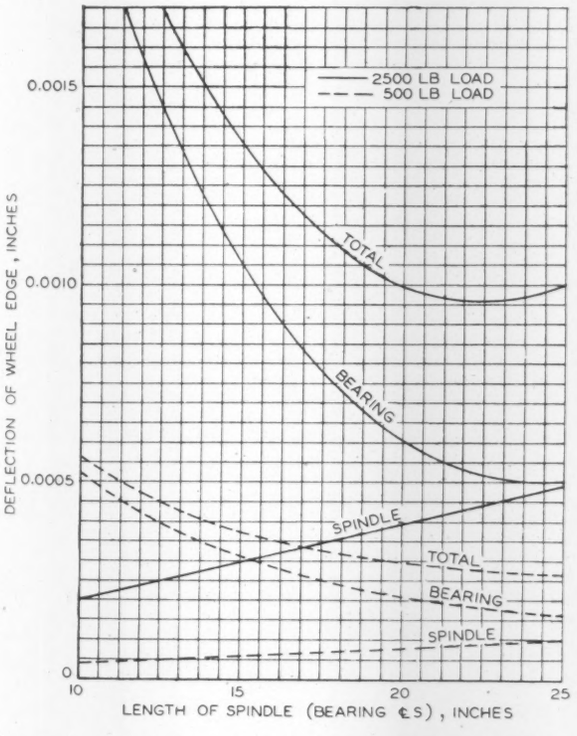


FIG. 3 CURVES OF BEARING AND SPINDLE DEFLECTIONS

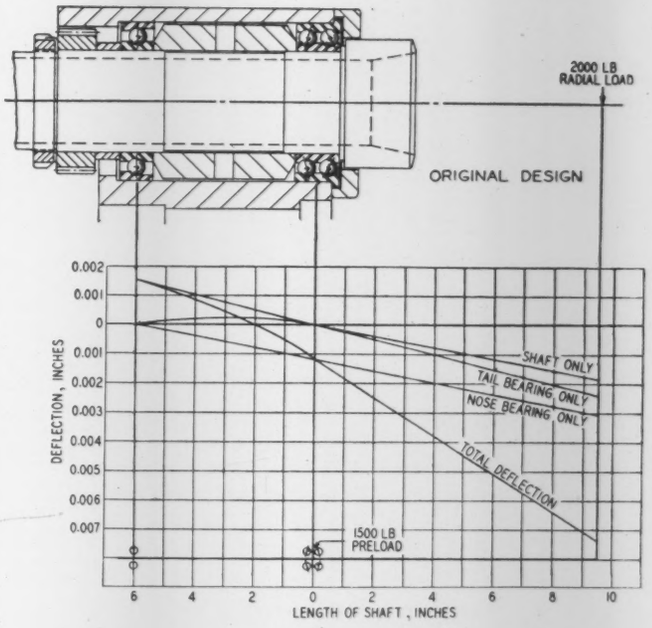


FIG. 4 DEFLECTIONS OF BEARINGS AND SHAFT OF TWO-BEARING HEAVY-DUTY SHAFT FOR A MULTIPLE-SPINDLE AUTOMATIC

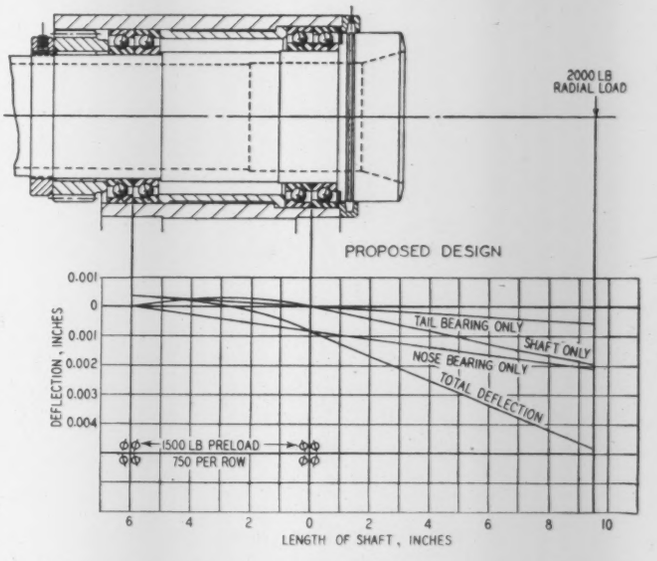


FIG. 5 DEFLECTIONS IN REDESIGNED SPINDLE, UTILIZING TWO BEARINGS IN PARALLEL AT EITHER END

The maximum calculated yield at the work of 0.00093 in. seemed somewhat high compared to the measured figure of 0.00074 previously given, but the difference is probably entirely due to the small stiffening effect of the clamping and sleeves on the spindle. The calculations first assumed a straight spindle of the same bore as that inside the front bearings, $1^3/_4$ in. An equivalent shaft diameter of $2^1/_{32}$ in. would show exactly the same calculated and measured deflection.

This approximate check of the existing spindle gave authority to the proposed method of calculation, and permitted the next step, which was to try different designs on paper, by calculating the deflections before building the spindles, instead of afterward.

Incidentally, the original work head contained some springs in the space back of the tail bearings. Deflection readings with and without these springs showed a very slight increase in

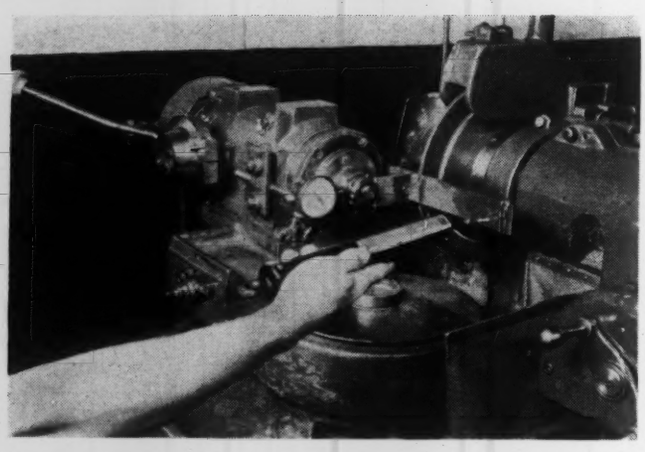


FIG. 6 TEST ARRANGEMENT FOR COMPARING RIGIDITY OF PARTS OF OSCILLATING-RACE GRINDER

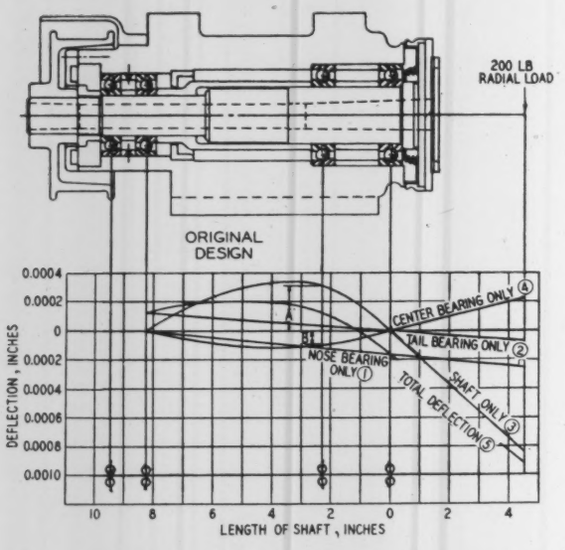


FIG. 7 ORIGINAL WORK HEAD AND DEFLECTION CURVES

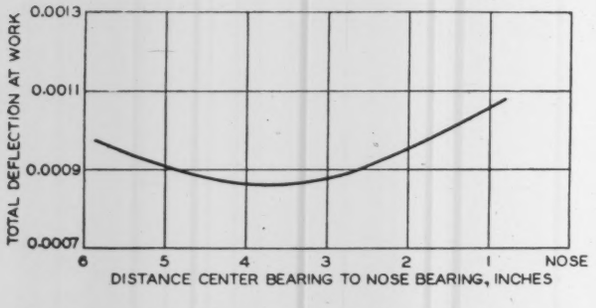


FIG. 8 SPINDLE DEFLECTION VERSUS CENTER-BEARING SPACE OF REDESIGNED WORK HEAD

yield (about 4 per cent) when the springs were introduced, probably because some of the preload became shifted from the nose bearing to the center bearing where it has less effect. Hence these springs were omitted in the calculations.

SPREAD OF BEARINGS

The first redesign calculation determined the effect of moving the center bearing either forward or backward. The entire calculation of Fig. 7 was repeated with the center bearing shifted first one way and then the other, resulting in the curve of Fig. 8. The optimum position, between 3 in. and 5 in. back of the nose bearing, already obtained practically. Although the center bearing was only 2.3 in. back, the angularity of contact in the ball bearing produces an effect equivalent to having the bearing slightly farther back.

The evident conclusion is that the work head under consideration could not be helped much by shifting the center bearing. However, this is not always the case; another set of calculations for a spindle in regular use on a lathe showed the center bearing to be placed exactly where it did the least possible good, that is, exactly at the point where the upward arcing of the spindle just equaled the downward yield of the nose bearing (*A* and *B*, Fig. 7).

TWO-BEARING MOUNTING

The next step was to check the possibility of changing to a two-bearing mounting, primarily to permit a very much heavier spindle, since the spindle deflection constituted the

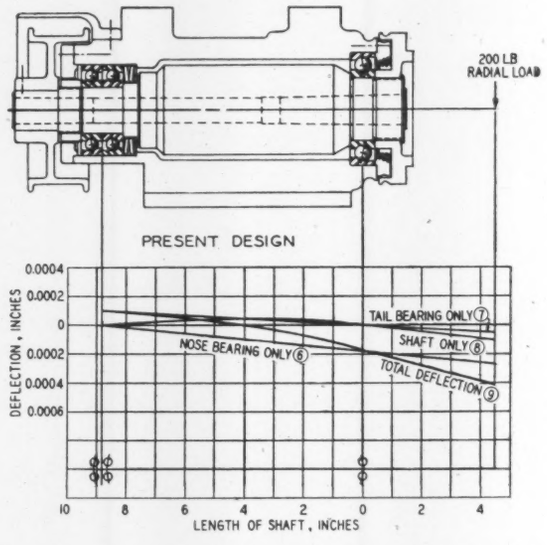


FIG. 9 FINAL DESIGN AND DEFLECTION CALCULATIONS

largest single item. Furthermore, such a two-bearing mounting would no longer depend upon the stiffening effect of the center bearing. Thus it would give more permanent accuracy and more consistently obtained accuracy, as neither is affected by inaccuracies in the initial bearing or its mounting or subsequent errors.

Fig. 9 presents the final design and deflection calculations. The greatest improvement came from the much heavier spindle, since the deflections fall off with the fourth power of the spindle diameter.

At the tail end are two bearings together just to permit smaller bearings, tucked inside the pulley, also cutting down possible belt effect on the work. A pair of heavy belleville springs provides a controlled preload but can be omitted in larger and shorter spindles.

The total calculated deflection drops from 0.00074 to 0.00041 in. The work head was rebuilt along these lines and showed a considerable and desirable improvement in quality of finish under very heavy grinding cuts.

Deflection measurements on the rebuilt spindle checked the calculations almost exactly 0.00040 in. measured, as against 0.00041 in. calculated.

In general the two-bearing mounting with a much stiffer and shorter spindle is always preferable with antifriction bearings.

Design of the UNION PACIFIC STEAM-ELECTRIC LOCOMOTIVE—II

By A. J. WOODWARD and B. S. CAIN

GENERAL ELECTRIC COMPANY, ERIE, PA.

(*Continued from the October issue*)

CONDENSERS

The steam condensers are built in sections on each locomotive unit. Each section is made up of vertical finned tubes between upper and lower headers. One section is shown in Fig. 12.

Temperature control is provided for on both sides of the unit to take care of strong side winds in cold weather.

The louver blades are specially shaped to develop some pressure due to motion of the locomotive. This would presumably increase the air resistance of the locomotive, but the condenser fans also discharge through fixed louver blades which direct the air backward, recovering the loss.

The condenser fans, four in number, are of the aphonic type with steel hubs and cast-aluminum-alloy blades. They are driven from one turbine through a line shaft and four right-angle-drive gearboxes. This drive was selected because studies of relative weight and space showed the turbine mechanical drive to be particularly suitable in this application. A fan and gearbox are shown in Fig. 13.

The turbine, which takes steam from the auxiliary-turbine exhaust and discharges into the condenser, is mounted on the boiler auxiliary set so as to be a part of that set.

CONDENSATE RETURN SYSTEM

By throttling steam admission to one condenser section connected to the lower condensate tank, a pressure difference is created which insures adequate drainage of the other sections under the comparatively small gravity head available and under conditions of acceleration and braking. A similar section connected to the high-level condensate tank draws noncondensables from this tank and discharges them to the ejectors. By suitable design, the high-level tank is used for deaeration and oxygen-free water is delivered to the boiler.

EVAPORATOR

The evaporator, shown in Fig. 14, uses extraction or high-pressure steam in a coil to generate steam at 230 psi for train heating, power-plant make-up, locomotive and fuel-oil heat, and fuel atomization. The entire high-pressure tube assembly is removable for inspection and cleaning when required. In normal service the evaporator is blown down at regular intervals and scale accumulating on the tubes may be cleaned off with the evaporator in place.

The evaporator is rated at 4000 lb of steam per hour but has proved capable of considerable overload.

STEAM PIPING

Conditions of locomotive operation introduce factors in the design of high-pressure piping which are a little different from those on stationary applications. The limited space and requirements of light weight make it essential to use as direct lines and as light fittings as possible. Against this must be balanced the expansion stresses which have to be kept moderate in order to avoid both creep in the piping and undue forces on the steam equipment. The locomotive has a comparatively flexible structure to which the pipes must be anchored and buffing and other forces due to motion make it necessary to clamp the piping so that no part can vibrate.

Sliding and flexible clamps are used to a considerable extent and pipe expansions were carefully calculated and checked experimentally in important cases. Carbon-molybdenum tubing is used for high-temperature lines.

The arrangement of equipment was dictated by the space and weight distribution. The 1500-psi steam lines lead (*a*) from the superheater outlet to the main-turbine throttle valve, (*b*) from the throttle valve to the auxiliary-turbine control valve and to the braking-resistor injectors, (*c*) from the throttle valve to the evaporator control valve.

Wherever possible, piping has been welded, since it is considered that a welded joint is the best that can be made as well as being the smallest and lightest. A considerable number of flanged joints have also been used where they may have to be broken for maintenance. In general the principle was followed that, if any apparatus required major repairs, it should be quickly replaced by a spare, to avoid holding the locomotive out of service. Therefore the steam pipes are flanged to allow removal and replacement of the boiler, turbines, evaporator, and similar equipment without requiring welding on high-pressure steam lines. Similarly, flanges are provided to allow for cleaning and draining the boiler circuits and inspecting spillover lines, without requiring welding. The wide range of country over which the units operate makes it necessary to provide for taking care of this class of work without skilled men.

LUBRICATION

The importance of proper lubrication of the equipment is recognized by the provision of exceptional safeguards. The main-turbine set has a mechanically driven lubricating pump and starting and stand-by motor-driven pumps. This lubricating oil is also used to cool and lubricate the main-generator bearings which are fed and drained by motor-driven metering pumps. The auxiliary set is lubricated by motor-driven pumps. The lubricating oil is cooled in heat exchangers, which are cooled in turn by an antifreeze solution which is pumped through radiators mounted in front of four of the steam-condenser sections. There is also provision for heating the lubricating oil in cold weather by steam. Pressure and temperature protective devices will trip out the equipment in case of any failure of the lubricating-oil system.

ELECTRICAL EQUIPMENT

The main traction generators are connected in series and the midpoint is grounded so that no point on the main circuits is normally above 700 volts to ground. The six traction motors are arranged for connection in three different combinations across the two generators, all six in series, two parallel groups of three in series, or three parallel groups of two in series. The combinations are obtained through electropneumatically op-

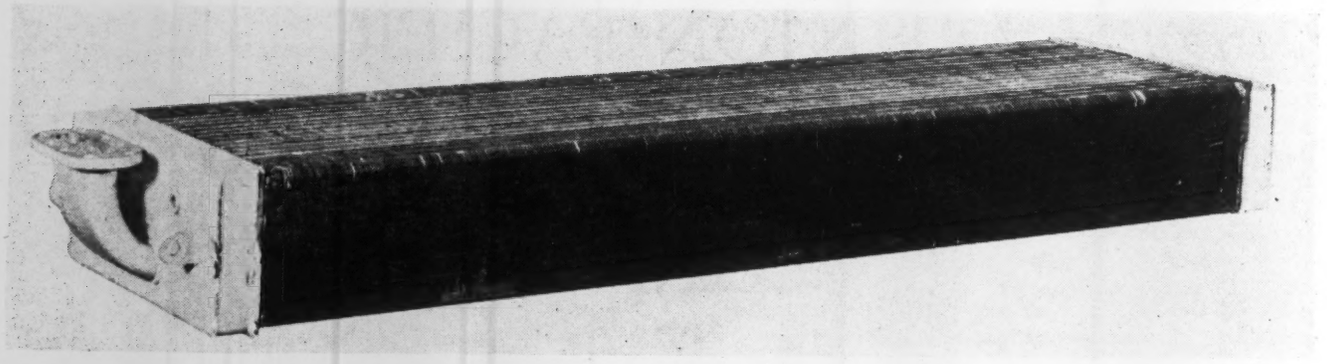


FIG. 12 STEAM CONDENSER SECTION

erated contactors, which also allow any pair of motors to be cut out.

With two motors cut out, series-parallel control is available on the remainder. It is also possible to cut out either generator and to operate with the other.

The master controller has motoring, braking, and reversing handles, interlocked with each other. There are 21 steps of motoring and 20 steps of manual electric braking.

The multiple-unit control permits both locomotives to be controlled by one man from either master controller. Since both steam controls are automatic, the two power plants will deliver all the power called for by the electric control up to the capacity of the plants and the two can be equalized by adjustment of the maximum steam flows.

Speed control on each unit protects the power plant from excessive demands by reducing the electrical demand if the main turbines slow down more than allowed for normal regulation. Thus, under conditions of maximum power demand, the electrical equipment is automatically regulated to use all the power which the prime mover is set to deliver.

Electric braking may be operated manually from the master controller or automatically from the brake valve in conjunction with air brakes on the train. In the latter case the supply of air to the locomotive brake cylinders is cut off and electric braking is controlled by the air pressure to give slightly less braking than would have been obtained by the air brakes. This results in stretching the slack in the train and produces a smooth stop. The electric braking is limited by current-limit and power-limit relays to the capacity of the equipment and higher braking is also obtained automatically on streamlined trains than on conventional trains due to the higher brake-cylinder pressures. The motors deliver up to 3600-kw of regenerated power during braking over a wide speed range as shown in Fig. 15. In case automatic electric braking should be lost due to any cause, the air brakes immediately apply on the locomotive to take its place.

The electrical couplers between locomotive units include two control couplers and a 3-phase alternating-current line supplying one of the train circuits from the front locomotive alternator. The trains have three separate 3-phase lines and the other two are supplied from the alternator on the second unit. The alternators are never paralleled. A 2-point battery-charging coupler is also provided to charge the 64-volt streamliner batteries from a motor generator set on the locomotive.

The engineman has instruments showing train speed, motor current, motor temperature, and main-generator speed in addition to the usual air gages. No steam pressure or other power-plant gages are before the engineman.

An alternating-current generator, driven by a 3-phase induction motor furnishes power for control and battery charging. Under normal conditions this receives power from the main alternator, but is also useful in stations if the main set is shut down and wayside alternating-current power is available.

The electrical equipment is described in detail in another paper,[1] and the description here is therefore brief.

MAIN GENERATORS

The main generators can deliver their full rating over the entire practical operating range of locomotive speeds, allowing full utilization of the prime-mover output. The high speed and restrictions on weight resulted in the design of a hollow cylindrical rotor in a skeleton stator which gives great rigidity with minimum weight.

The rotor is self-ventilated by a fan between the two armatures which discharge into a scroll exhausting out of the cab roof or into the cab for recirculation.

The exciter and auxiliary alternator, combined in one machine, are direct-connected to the main generator.

[1] "Electrical Equipment of the Union Pacific Steam-Electric Locomotive," by M. R. Hanna and J. F. Tritle, A.I.E.E. Convention, San Francisco, Calif., 1939. To be published in A.I.E.E. Trans. in 1940.

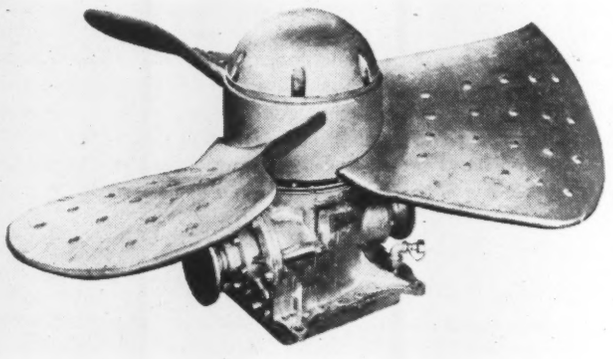


FIG. 13 CONDENSER FAN AND GEARBOX

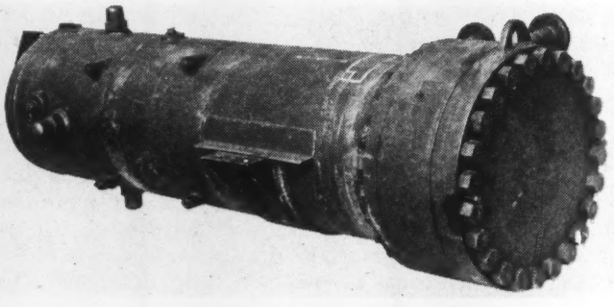


FIG. 14 EXTERNAL VIEW OF EVAPORATOR

TRACTION MOTORS

The six motors on each unit are axle-hung, geared to the axles through single, solid, spur gears. The motors have eight poles and have capacity over an extreme range of speed. With normal ventilation of 2000 cfm of air per motor the 12 motors rate 64,000 lb tractive effort continuously, while on heavy grades with full ventilation of 4000 cfm of air per motor they rate 81,000 lb tractive effort. The maximum speed of 125 mph results in a ratio of maximum speed to rated speed of more than 5 to 1.

The gearing presented problems in adequate lubrication over the range of speeds and temperatures met in service. An extreme-pressure lubricant is used, with the teeth lubricated by oil jets at high speed.

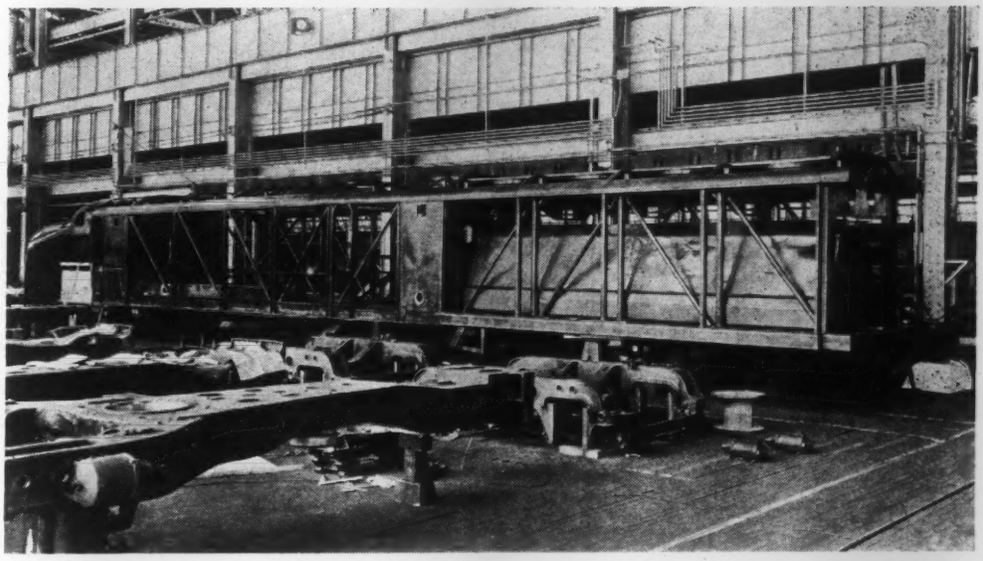


FIG. 16 CAB STRUCTURE

AIR COMPRESSORS

The main air compressor on each unit is motor-driven from 3-phase alternating-current power. Each unit also has two auxiliary compressors which are direct-current-operated. These are used for control in starting and also in emergency in case the main-reservoir pressure falls below 115 psi.

MECHANICAL CONSTRUCTION

The body of the locomotive is designed to combine great strength and stiffness with light weight. The main members are welded high-tensile steel while the side sheets, roof sheets, hatch covers, bulkhead sheets, and secondary supports are aluminum except for the front nose sheets, which are steel.

The structural steel used has a high tensile strength and combines strength and resistance to fatigue with low carbon content and good welding qualities.

The cab structure is shown in Fig. 16.

The main strength of the frame is in two side trusses with top and bottom chords of T-section and hollow rectangular vertical and diagonal members. The hollow compression members are designed to develop 90 per cent of the full elastic strength of the alloy before buckling.

Tests were made on a number of sample members of different thicknesses to check this. The samples were 100 in. long, 4 × 4 in. hollow section with $^1/_8$-in. and $^3/_{16}$-in. walls containing two longitudinal seam welds. With an l/r ratio of 63, these samples started to buckle when the compressive stress reached about 50,000 psi. In the actual locomotive the walls of these hollow sections are $^3/_{16}$ in. or thicker and the actual stresses are conservative.

The locomotive centerplates are welded integrally with multiple box-section bolsters. These are welded into the side trusses and into two widely spaced center sills which support the heavy apparatus and are in turn supported from the trusses by cross members. The whole structure is cross-braced to give torsional strength.

The aluminum cab sheets are riveted to the steel structure and stiffened with particular regard to avoiding buckling due to difference in thermal expansion.

Almost the entire roof is removable in sections for maintenance purposes and even the largest sections, of welded and riveted aluminum, can be handled by a shop crew without a crane, if necessary.

The air taken into the engine room for ventilating the generators, traction motors, and small equipment, enters through louvers in the cab sides and also through raised intakes in the roof. The side louvers have a labyrinth section which reduces the amount of dirt and water in the air and all air intakes can be closed when the power plant is shut down.

There is a vestibule at the rear of each unit. An outer rubber sheet forms a flush outer vestibule when the unit is coupled to a streamlined train and an inner steel and fabric structure is designed to connect to a streamlined train, to a standard car, or to the nose of the second unit.

The driving trucks have integral cast-steel frames, with the cab carried on two flat center plates and four spring loading pads at the inner ends of the truck frames. The spring rigging contains a combination of coil and

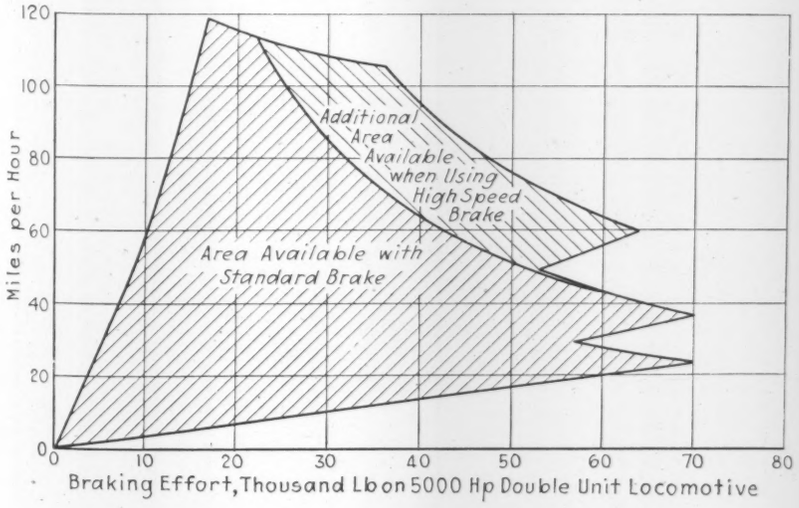


FIG. 15 ELECTRIC BRAKING CHARACTERISTICS 5000-HP LOCOMOTIVE

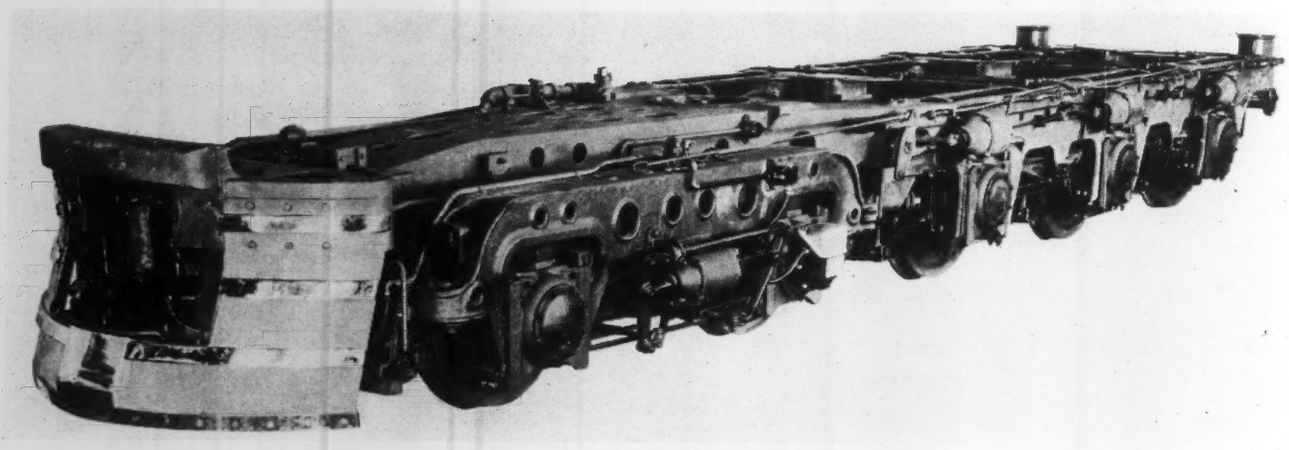


FIG. 17 FRONT DRIVING AND GUIDING TRUCKS

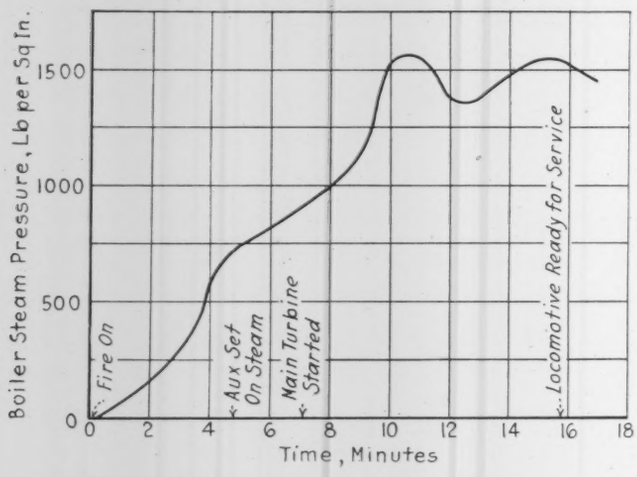


FIG. 18 TEST RECORD OF POWER PLANT START ON BATTERY

plate springs with coil springs directly over each driving box.

The guiding trucks also have cast-steel frames and are designed with variable restraint rocker centering devices with high initial restraint, dropping off to a low value on sharp curves. The front driving and guiding trucks are shown in Fig. 17.

The truck stabilizers are a development of those used on high-speed electric locomotives. Each guiding truck is connected to the driving truck by a spring-cushioned radius bar which permits the truck to take curves freely but prevents oscillations. Each driving truck is also connected to the main cab structure by a spring restraint at the inner end.

The front driving truck restraint is simply a cushioned lock which holds the truck in the central position. On curves the restraining force drops to zero so as to allow free motion. The rear driving truck restraint is much heavier and acts on curves as well as on straight track. This guides the rear truck and also stabilizes it against oscillation.

Observation of the trucks at speed shows that they run steadily and are completely free of any objectionable oscillation. At the same time the locomotive can negotiate 20-deg curves either forward or backward.

The front coupler is retractable and doors are provided in the pilot so that when the coupler is drawn back the front end will be smooth and free from projections. The rear coupler is attached to the truck frame through a rubber draft gear and universal joint. The axles are annealed carbon steel with roller-bearing journals. The wheels are rolled steel, 44 in. in diameter on the driving axles and 36 in. on the guiding axles.

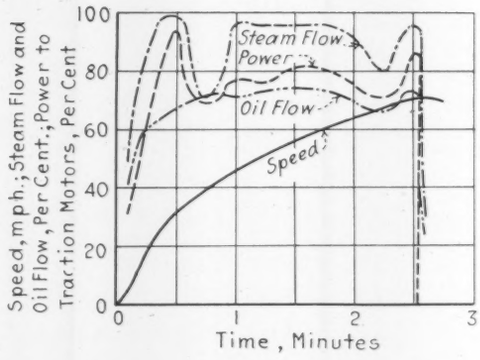


FIG. 19 TEST RECORD OF ACCELERATION OF ONE 2500-HP UNIT WITH ONE TRAILING CAR

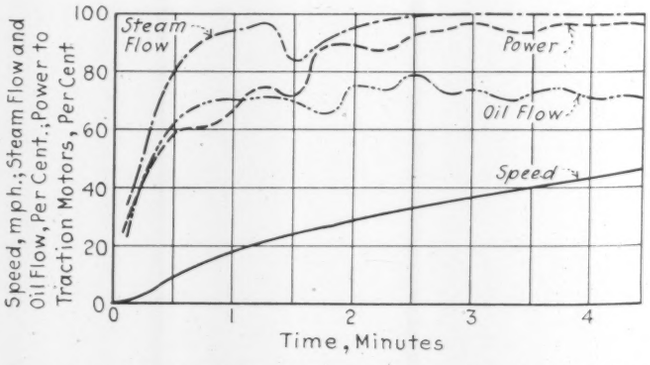


FIG. 20 TEST RECORD OF ACCELERATION OF ONE 2500-HP UNIT WITH 980-TON TRAILING TRAIN

The brake rigging is designed to combine high braking power with light weight, freedom from rattle and vibration, and protection against dust.

Each driving wheel has its individual brake cylinder and rigging with four brake shoes per wheel. The two cylinders for each axle are permanently equalized by an air line. The guiding trucks have two brake cylinders and a mechanically equalized rigging with two shoes per wheel. The braking ratios are 213 per cent on the driving wheels and 56 per cent on the guiding truck wheels, based on full load and 100 psi brake cylinder pressure.

TESTS AND OPERATION

Many tests were made of equipment prior to the design of this locomotive. The boiler and steam controls are based on

experience which included test operation of a steamotive boiler with auxiliary set and automatic control, which has already been described.[2]

Sample condenser sections were tested for steam condensation, heat transfer, and air resistance before the final sections were built and wind-tunnel tests were also made of models to study the air flow and the effect of various designs and arrangement of louvers at varying air speeds. Model tests were also made on the condenser fans. Finally, a full-size test was set up embodying one fan and one quarter of the total condenser, and steam condensation, drainage, and air-removal tests were made under various conditions. Practically all the final equipment except the boilers was tested individually before installation in the locomotive.

After completion, the locomotive was put on a stationary test in which the traction generators were loaded on a water box, so that the complete power plant could be tested under any load under conditions similar to those in service except for the actual motion of the unit over the track.

After considerable checking and some minor modifications to improve performance, the units were tested on load cycles corresponding to those which may be expected in actual service.

The locomotives were also given track tests to insure proper operation under actual conditions. Tests up to 75 mph were made on the General Electric test track at Erie with both single- and multiple-unit control of the two power units. Loaded coal cars were used to simulate the trains to be hauled.

A single unit was then operated hauling empty passenger cars on the New York Central main line between Erie, Pa., and Dunkirk, N. Y.

Finally, the double unit was put in operation in regular revenue passenger service on the New York Central Railroad lines between Buffalo, N. Y., and Cleveland, Ohio, for a period of ten days.

After final inspection, the locomotive was delivered to the Union Pacific Railroad under its own power and was tested hauling revenue trains on various sections between Omaha, Neb., and Los Angeles, Calif.

[2] "Steamotive," by E. G. Bailey, A. R. Smith, and P. S. Dickey, MECHANICAL ENGINEERING, December, 1936, pp. 771–780.

TABLE 1 SUMMARIZED DATA FOR EACH 2500-HP UNIT OF UNION PACIFIC–GENERAL ELECTRIC STEAM-ELECTRIC LOCOMOTIVE

Total weight (each unit, fully loaded), lb	548,000
Weight on drivers (each unit, fully loaded), lb	354,000
Weight per driving axle, lb	59,000
Weight per guiding axle, lb	48,500
Length over couplers, each unit	90 ft, 10 in.
Width over cab	10 ft
Height over-all	15 ft, 3/4 in.
Diameter driving wheels	44 in.
Diameter guiding wheels	36 in.
Total wheel base	78 ft, 8 in.
Maximum rigid wheel base	13 ft, 4 in.
Maximum starting tractive effort (each unit), lb	86,500
Rated tractive effort (normal blowing, each unit), lb	32,000
Rated tractive effort (super-blowing, each unit), lb	40,500
Maximum speed, mph	125
Main steam pressure, lb per sq in	1500
Steam temperature, F	920
Rated output for traction (each unit), hp	2500
Rated output of train heating steam (each unit), lb per hr	3000

Test records which may be of interest are shown in Figs. 18, 19, and 20. Fig. 18 shows a typical start of the power plant from the storage battery after a complete one-hour shutdown. The record shows that the auxiliary set was put on steam in 4 3/4 min and that the main set was up to speed and the locomotive ready for service in less than 16 min. Fig. 19 shows a typical acceleration of one unit and a single car from standstill to 70 mph on the test track. Fig. 20 shows a typical acceleration of one unit and 980 trailing tons, approximately twice the load for which it was designed, also on the test track. The fluctuations of power and steam flow in both records are not significant and vary according to the way the train is handled on different occasions, but the averages are typical.

Fig. 21 shows one of the units on stationary test at Erie, connected to the waterbox.

FIG. 21 2500-HP UNIT ON STATIONARY TEST CONNECTED TO WATERBOX LOAD

UNIONIZATION *of* ENGINEERS

(*Continued from page 789*)

a professional engineer, however badly underpaid he may be, should resort to union membership and activity to improve his condition.

The final answer or solution probably cannot yet be written. More experience must be had. But at the present stage of development there surely appear to be grave doubts as to whether professional engineers and labor unions have enough in common to justify their getting together.

RESPONSIBILITY OF ENGINEERING SOCIETIES

The engineering societies should charge themselves with responsibility relative to the economic status of all professional groups and remove from the minds of the members the question of fair compensation and continuity of employment. The employed engineer desires, above all else, a fair compensation and steady employment, thus removing from his mind concern for his family and for himself, and permitting him to function whole-heartedly as an engineer. It is to be hoped that collective bargaining need not be resorted to if the societies will set up proper procedure in their own groups and provide code authority to cover such need.

The industrial employer might object to including salary schedules in engineering society codes, and to society influence behind such schedules. It would appear, however, that either something of this kind must occur or the employer will be forced to deal with a union or some other agency which may not be intelligent or sympathetic with the employer problem. Possibly the societies of professional engineers could serve as this agency.

SUBPROFESSIONAL GROUPS

There is conflict between the union idea and the professional idea but an adjustment may be possible if a clear line of demarcation is ever established between the professional and the subprofessional groups without either suffering loss of position. The development of industry and of engineering brought into being an intermediate class which can be termed subprofessional and which is composed of draftsmen and technicians, whose occupation is the production of drawings from designs of the chief or assistant chief draftsman or the engineer in charge of the work, the running of routine tests according to specification of engineers, and other similar work. The subprofessional class might be defined as that group whose members could not qualify for membership in a founder engineering society, or could not qualify for registration under the various state registration laws.

Although it may be long before the relations of labor unions and the engineering profession are clarified, it is necessary, even now, for engineers and engineering societies to recognize the problem and to provide for younger engineers the result of at least such thinking on the matter as may now be done. This has been written with that object in mind. The young engineer may not yet receive a final answer to his question, but he may be shown how union and professional ideals compare and that should be of considerable assistance to him.

It is possible that this paper may induce others to express their thoughts in the matter, and out of the discussion may result a much clearer understanding of the problem than we now possess.

EXTRA-TARIFF CONTROL *of* FOREIGN TRADE

(*Continued from page 790*)

lodged with those who administer the acts. What, for example, is meant by "dumping?" What items must be considered in deciding whether there is in fact price discrimination between the markets under consideration? Or again, when has a foreign country given such bounties as to justify countervailing duties? Or finally, consider the discretionary power placed in the hands of those who shall decide to impose penalizing duties against imports from a certain country because that country is discriminating against America.

A third area in which human discretion (government by men rather than laws) is important lies in the broad field of tariff barriers aimed at the protection of the public health, safety, and morals of the nation. The limits of this review do not permit any extended analysis of the implications of these laws as interpreted and applied. Something of their importance may be gathered when one realizes that the administration of these items is, at least in part, lodged with the Secretary of Agriculture. A designing secretary might, with no little public support, distort the law in its operation to an agency for shutting out foreign articles of food (meat for instance) to the advantage of the American farmer. In this connection the political power of organized pressure groups must not be overlooked. The unfortunate Argentine episode was an example of strained international relations resulting from what many at least considered an abuse of the tariff embargo as a protective measure. It is only fair to record that in this instance, Congress rather than administrative officials made the decision.

The foregoing are some of the places suggested by "The Invisible Tariff" where legislation may to all intents and purposes be enacted by extra-congressional agencies as they carry out the administrative duties required of them. As to the general reasonableness—even necessity—of the development here considered, few will offer opposition. But as to the dangers inherent in the situation as it has developed, all should be aware. Fears are aroused not by the economic aspects of the situation but by the political. First of all in the field of foreign trade, economic decisions based on ostensibly rational economic judgments may become in fact little less than economic sanctions against nations whose governments and foreign policies are disapproved by those in charge of the administrative processes. Certainly, decisions that may be a first step toward international involvement should be made, if made at all, by the responsible representatives of the people clothed with constitutional legislative authority and not by limited groups appointed by the Executive and clothed at best with delegated authority sometimes of doubtful legality. Finally, in this as in all other areas where the administrative process of legislation has taken hold, there lurks the possibility if not the danger of that usurpation of control which may some day lead to the American brand of authoritarianism.

DIRECT ROLLING *of* METAL

The Production of Strip Metal of High Melting Points Directly From Molten Metal

By C. W. HAZELETT

HAZELETT METALS, INC., NEW YORK, N. Y.

FOR the benefit of those unfamiliar with the history of direct rolling of metal, i.e., without first casting the molten metal into ingots, I shall review briefly significant attempts which have been made in this direction.

BRIEF REVIEW OF ATTEMPTS AT DIRECT ROLLING

Sir Henry Bessemer did sufficient experimental work between 1845 and 1860 to be convinced that the direct rolling of steel could be done. In the early nineties, Norton and Hodgson carried on extensive researches and concluded that it could be done. In 1921, I developed a machine which would produce continuous strips of antimonial lead for the production of storage-battery grids; one of these machines is still in commercial use. It consisted of a single cooled drum with a spaced, stationary, copper shoe, through which the metal was poured. Later I developed a double-horizontal-roll casting machine which produced satisfactory strip of high quality as to structure, gage, and surface, from lead, tin, and their alloys.

A few years ago I did some development work in the production of brass strip. With the cooperation of the Scovill Manufacturing Company, of Waterbury, we succeeded in producing substantial tonnages of 12-in-wide, sound brass strip, of good physical characteristics, in strips weighing up to 3000 lb. The costs were low, and the metal was sound; however, red stains in the surface, due to segregation, made the product unsalable where high finish or chromium plating was required. To correct this condition, of course, would require the use of two processes in a plant and would vitiate a large part of the advantages due to lower costs. A little later, the Crown Cork and Seal Company, of Baltimore, undertook to commercialize the production of aluminum strip. They succeeded in producing large quantities of strip 24 in. wide, sound, accurate in gage, but still having substantial segregation, since the metal was, of course, alloyed with copper.

Obviously, the rolling of alloys had its disadvantages because of the segregation inherent in the operation of these particular machines. This segregation came about because of irregularities in cooling, due to a folding of the frozen films in contact with the rolls, which, in turn, was due to the fact that the frozen film did not travel at the same speed as a point on the roll. At the pass where high pressures were being applied to the partially chilled alloy, the lower-melting-point constituents of the alloy were forced into the places of least cooling and least pressure. It is to be noted that all of these mills performed substantial work on the product.

The most refined work on one of these mills has been done recently by the American Metal Company in conjunction with the Scovill Manufacturing Company, a motion picture of which has been made.[1] In this work they confined their efforts to a pure metal, copper, which of course would not be subject to segregation. They applied a most carefully developed system of controlled atmosphere in the furnace, the runners, and in shrouds about the mill itself, in order to produce oxygen-free, or the so-called OFHC, copper strip.

In all of the afore-mentioned work it may be said that we have succeeded in producing sound metal, of great length, straight, flat, with sufficiently accurate gages for rerolling, at widths up to 24 in., at low cost, and with commercial roll life for all of these metals. The Crown Cork and Seal Company has rolled substantial tonnages of low-carbon steel, 24 in. in width, of very good quality. The International Nickel Company has also rolled a substantial quantity of nickel and monel metal. However, the roll life with these high-melting-point metals was hopelessly short for commercial results compared with other processes, and of course the surface became rapidly defective.

SOME OF THE PROBLEMS OF DIRECT ROLLING

Having summed up these accomplishments, which I believe are substantial, let me summarize our essential problems at this

[1] In presenting the paper, Mr. Hazelett plans to show this picture as well as motion pictures of the newer high-speed-type mill.—EDITOR.

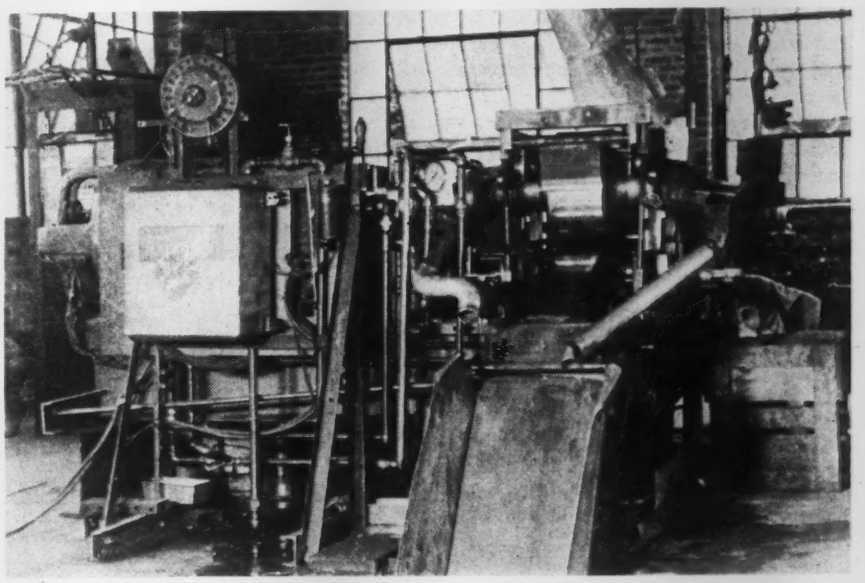


FIG. 1 MILL FOR THE DIRECT ROLLING OF METAL

Contributed by the Iron and Steel Division for presentation at the Annual Meeting, Philadelphia, Pa., Dec. 4–8, 1939, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

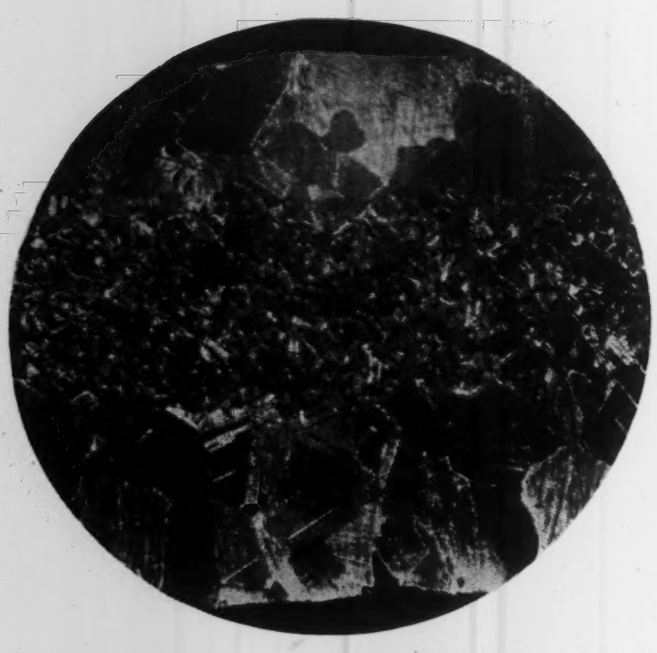


FIG. 2 PHOTOMICROGRAPH OF DIRECT-ROLLED BRASS AS RECEIVED FROM MILL, SUITABLY ETCHED, UNDER POLARIZED LIGHT. (×200)
(Original magnification slightly reduced.)

stage. They were: First, segregation; second, our inability to get thin gages due to the increasing effect of the afore-mentioned folding as thinner strip was manufactured; third, higher speeds (all of the before-mentioned operations were carried out at speeds between 15 and 50 fpm); and, fourth, lower roll or cooling surface cost per ton, particularly with steel, monel metal, and nickel.

To solve the problem of segregation, it was decided that molten metal should be poured first on one cooling member where it would be allowed to chill almost throughout its thickness and then that it should be surface-rolled to chill and compress the very small film of unsolidified metal. To do this, it was necessary to form the bath of molten metal on one surface instead of between two rolls, as had been done heretofore. This has been achieved by pouring molten metal both on the outside and on the inside of a cylindrical surface, but here important difficulties had to be overcome. These surfaces first had to be degassed to get a sound metal, and then they had to be cooled at high rates for continuous production. This has been achieved. When we remember that the strip is solidified almost throughout before the surfacing roll finishes it, we see that no folding takes place and that segregation has thus been eliminated.

The production of thinner strip has been worked out primarily by the use of high speeds and very short contact between the molten metal and the cooling surface. For example, we produce strip 0.025 in. in thickness at 500 fpm with a contact of 2 in. or in an elapsed time of $1/50$ sec. Obviously, the greatest savings are in the production of thin strips, and large markets are here also.

As stated previously, we can produce thin gages at present at speeds up to 500 fpm with every indication that these speeds can be increased to the point where centrifugal force would throw the metal off of the cooling surface when pouring on the outside of the roll. I should estimate that it is practical to operate at speeds of 1500 to 2000 fpm. However, a continuous speed of 500 fpm, such as we have already achieved, seems to be fast enough for any commercial requirements compared with the intermittent feeding of ingots. One would of course expect little, if any, segregation to occur in such a short period of time as $1/50$ sec.

We are carrying on researches in the production of strip $1/4$ in. thick, and also in pouring the metal on the inside of a ring to form a bath in the lower part, moving the ring to carry the solidified strip out of the bath beneath a surfacing roll.

In order to reduce the cost of the cooling surface, instead of using expensive solid rolls and attempting to cool them on the outside, which would result in enormous fluctuations in temperature on that side and early fire cracking, we first successfully used a ring made from strip steel, driving it between two small rolls. The molten metal poured on the ring gives up the major portion of its heat of fusion thereto. This ring is very cheap; it can be 20 ft in diameter, if desired, and presents such an enormous amount of inexpensive cooling surface that high speeds and high production can be cheaply obtained. In order to avoid large amounts of scrap at the beginning of the heat, it is necessary to degas this ring by preheating it. For an upper roll, to surface the product, we have used internally cooled rolls that have extremely thin walls, as low as $1/8$ in., shrunk on splined shafts. It is an amazing fact that a roll as small as $2\,1/2$ in. in diameter with a $1/8$-in. wall will apparently run continuously at these high speeds without heating up, if sufficient quantity of water at sufficient pressures is forced through it. The roll pressures required on these mills are extremely light, running only a few hundred pounds per inch of width. This small surfacing roll somewhat parallels in operation a boiler tube, which, it is well known, will operate many months, 24 hr per day, with temperatures from 2500 to 3500 F on one side and circulating water on the other.

We have confined most of our efforts up to the present to brass. However, sample heats of copper, aluminum, low-carbon steel, and silicon steel have been rolled, with as good results as with brass at the time they were rolled, and much work is being done in this direction at this time. We can say definitely that our great difficulty due to stains and segregation in brass has been eliminated; that we can turn out gages as low as 0.015 in. in one operation; that we can roll strip at 500 fpm with sufficiently good gages for rerolling; and that our roll cost per ton has become an insignificant factor. The physical properties, surface, and grain structure of the various brasses, after a 50 per cent cold reduction and suitable annealing, are normal. Much work remains to be done on heavier gages and on all sorts of other metals and alloys.

FIG. 3 PHOTOMICROGRAPH OF BRASS ROLLED DIRECTLY TO 0.020 IN. AT 500 FPM; COLD ROLLED TO 0.010 IN. AND ANNEALED; SUITABLY ETCHED; SHOWING COMPLETE RECRYSTALLIZATION. (×200)
(Original magnification slightly reduced.)

RECEPTION LOBBY AT A.S.M.E. HEADQUARTERS, NEW YORK, N. Y., AS SEEN FROM DOORWAY OF THE COUNCIL ROOM

(Portraits of John Edson Sweet and Henry Rossiter Worthington, founders, hang over davenport and in alcove, respectively. Bronze portrait tablet in memory of Robert Henry Thurston, first president, is at left of John Fritz's clock.)

THE A.S.M.E. TODAY

II—An Elected Council Administers Society Affairs Through Committees Served by the Secretary's Staff at Headquarters

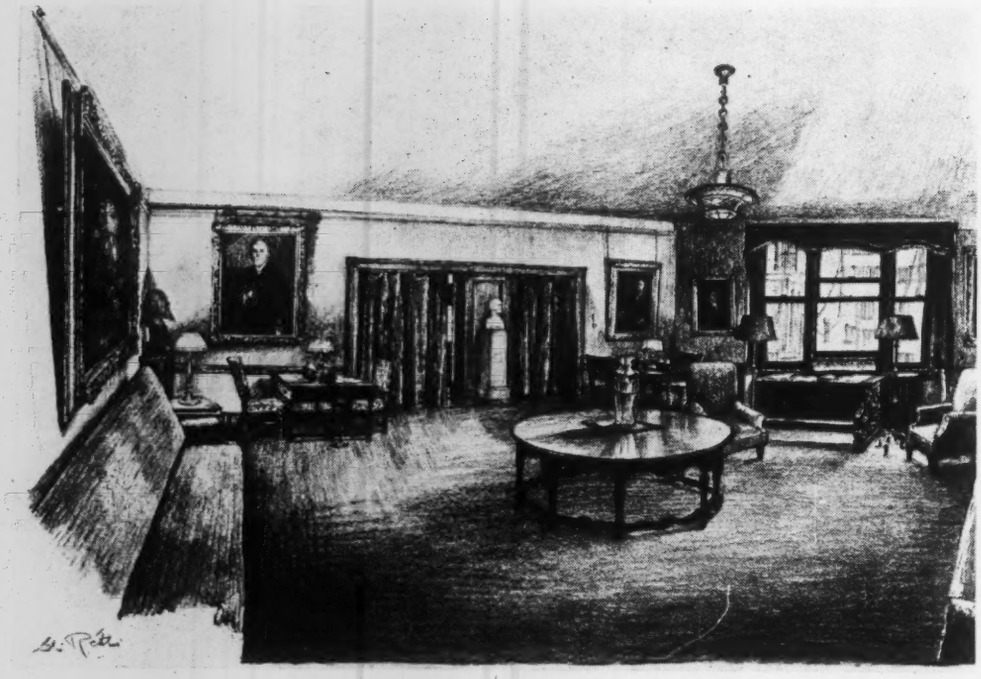
AT THE close of the Annual Meeting in December, The American Society of Mechanical Engineers begins a new administrative year. The newly elected president takes office. Three (on alternate years there are four) new vice-presidents and three new managers sit at the Council table. The chairmanships of practically every standing committee, and of many other committees, change hands. New members replace those who are retiring from the committees. Thus, without modifying the form of its organization and without serious or sudden shifts of policy and objectives, the Society is continually changing the personnel of administrative groups in such a manner as to provide an annual infusion of new blood. What this organization is, how Society affairs are administered, and what the work and functions of the Secretary and his headquarters staff are, will be described briefly in this article, which is the second of a series on the A.S.M.E. as it is today.

AN ELECTED COUNCIL IS IN CONTROL

Management of A.S.M.E. affairs is in the hands of a board of directors, chosen from its membership and styled the Council, which has full control over the activities of the Society subject to the limitations of the Constitution and the results of letter ballots. The directors consist of the President, seven vice-presidents, nine managers, and the last five surviving past-presidents, all of whom are elected by letter ballot of Society members following nomination by a national, geographically representative committee.

The officers consist of the President, seven vice-presidents, the Treasurer, and the Secretary. The President is elected for a term of one year, but for five years after his term of office expires he remains a member of the Council. It is his duty to appoint members of all Society committees and all representatives of the Society, subject to confirmation by the Council. The vice-presidents serve two-year terms, and the managers, three-year terms. Every year the Council itself appoints a secretary, who is the only salaried officer, and a treasurer. The Secretary and the Treasurer, who have no vote on the Council, are the only Society officers who may immediately succeed themselves. Chairmen of 16 standing committees serve on the Council as advisory representatives without vote.

The Council usually meets at least twice a year, during the Annual and Semi-Annual meetings, and may convene as often as it desires. An Executive Committee, of which the President



MEMBERS' ROOM AT A.S.M.E. HEADQUARTERS, NEW YORK, N. Y.

(The four portraits, left to right, are of Sir Isaac Newton, John Fritz, past-president and honorary member, Alexander Lyman Holley, founder, and Robert Fulton, painted by himself. Bronze bust at left is of Rear-Admiral George W. Melville, past-president and honorary member; marble bust is of James Watt. Behind the curtains are President's and Secretary's offices.)

is chairman, meets monthly to conduct business between meetings of the entire Council. With the President, two vice-presidents, and two managers and, as advisory members, the chairmen of the Committees on Finance, Local Sections, and Professional Divisions, serve on this committee.

ADMINISTRATION IS SUPERVISED BY STANDING COMMITTEES

Sixteen standing committees, under the direction of the Council, supervise the extensive activities of the Society and advise the Council on matters relating to their fields of authority. Members of these committees and any advisory or special representative affiliated with them are appointed by the president, usually on nomination of the committees themselves. The Secretary of the Society is also the official secretary of every Society committee.

The sixteen standing committees are as follows: Finance, Meetings and Program, Publications, Professional Divisions, Research, Local Sections, Admissions, Professional Conduct, Constitution and By-Laws, Library, Education and Training for the Industries, Relations With Colleges, Standardization, Safety, Power Test Codes, and Honors and Awards.

To coordinate the policies of committees whose activities include overlapping fields of interest, two advisory boards, one on professional status and the other on technology, are maintained. The chairmen of these boards are members of the Council, and committees whose interests are involved have representatives on the appropriate board. Standing committees having representatives on the Advisory Board on Professional Status are those on Admissions and Professional Conduct. A member of the Special Committee on Registration and one of the Society's representatives on the Engineers' Council for Professional Development also serve on this board. On the Advisory Board on Technology are representatives of the standing committees on Meetings and Program, Professional Divisions, Publications, and Research.

In addition to the 16 standing committees, there are also, at present, 16 special committees of the Council, whose names indicate in general their functions. They are: Registration, Biography Advisory, Certificate and Pin for Fellow Grade, Boiler Code, Manual on Citizenship, Dues Exempt Members' Contributions, Economic Status of the Engineer, Medals, Aims and Objectives, Board of Review (of dues-delinquent members), Manual of Practice, National Defense, Society Development, George Westinghouse Bust, Freeman Funds, and Education.

The constitution of the Society provides for a business meeting during the Annual and Semi-Annual meetings and for such special business meetings as shall be called by the Secretary upon written request of at least one per cent of the membership. An action of a business meeting is an action of the Society as a whole. There is thus provided means for members to take official action on any matters that, in their opinion, should be so handled.

This brief review of the organization of the Council and its major committees for purposes of Society administration will be supplemented in succeeding articles by more detailed explanations of the functions and operations of the principal agencies which conduct the Society's affairs. Before undertaking this task, however, it will help to clarify the relationship of the individual member to his Society to outline the organization of two agencies, local sections and professional divisions, with which he is personally concerned, and to explain the assignments to his headquarters staff made by the Secretary of the responsibilities of his office.

SOCIETY MEMBERSHIP IS GROUPED IN SECTIONS

The individual member of the Society may, by election or appointment, serve on the Council and any one of its committees and boards, but at any given time, relatively few members are so engaged. The member's personal relationships with these groups are therefore likely to be infrequent and remote. He may cast his ballot; he may attend the business meetings; but his principal contacts and interests are related to another pattern of organization which concerns the local sections, the professional divisions, the publications, and, in some cases, the technical committees. In future articles of this series these activities will be rather fully described; the purpose of the present article is merely to show how they are related to the Society itself in the administrative organization.

With the approval of the Council and under the supervision of the Committee on Local Sections, 70 groups of members of the A.S.M.E. have been organized and are functioning as local sections in as many industrial centers throughout the United States. Every member of the Society residing in the United States is a member of some one of these sections, and through this

local membership he has the privilege of enjoying a program of local activities. Each section administers its own affairs under the supervision of the Committee on Local Sections and subject to such rules and policies as the Council may set up. Selection of local officers and committees is a purely local affair. The section operates in general very much as though it were a local society. An allocation of funds from Society income budgeted for this purpose is made by the Committee on Local Sections to defray a portion, if not all, of the expense of each section's operation.

The sections offer three opportunities for the individual member to express his views on the formulation of general Society policies. The first is through the direct relationship of section officers with the Senior Councilors, the Committee on Local Sections, and the headquarters staff. The second is through the Nominating Committee for Society officers which is selected on the nomination of the officers of the sections organized in geographical groups. The Nominating Committee is eager to have individual members suggest names of properly qualified men for Society office. The third is through the conferences of representatives of the sections in each geographical group. At the Annual Meeting delegates from these Group Conferences meet together and with the Council to present recommendations. The representatives of the sections welcome suggestions as to matters that should be brought up for consideration by groups of sections and for presentation to the Council through the Conference of Group Delegates.

A fuller discussion of the Local Sections will be presented in one of the succeeding articles of this series.

PROFESSIONAL DIVISIONS GROUP MEMBERS ACCORDING TO THEIR INTERESTS IN ENGINEERING SUBJECTS

In addition to the grouping in local sections on a geographical basis, the membership of the A.S.M.E. is also organized along lines of common professional or technical interests. The groups thus set up are known as the professional divisions. Without payment of special dues, every member is permitted to register in any three of the 16 professional divisions at present in existence. Registration in a division entitles the member to receive notices of meetings sponsored by that division and any special publications issued gratis by it, and otherwise to take part in its affairs.

In effect, a professional division is a technical society within the organization of the parent society. Subject to the rules and policies of the Society and under the general supervision of the Committee on Professional Divisions, a division conducts its own affairs. It has its own executive and special committees. It may engage in many activities, such as the holding of national meetings or joint meetings with other societies. It sponsors sessions at meetings of the Society, and provides the program, papers, and special features that are appropriate to such occasions. In connection with the Annual Meeting and occasionally at other times, a Conference of Professional Divisions is held for the purpose of coordinating the work of the divisions and for the planning of programs for future technical meetings.

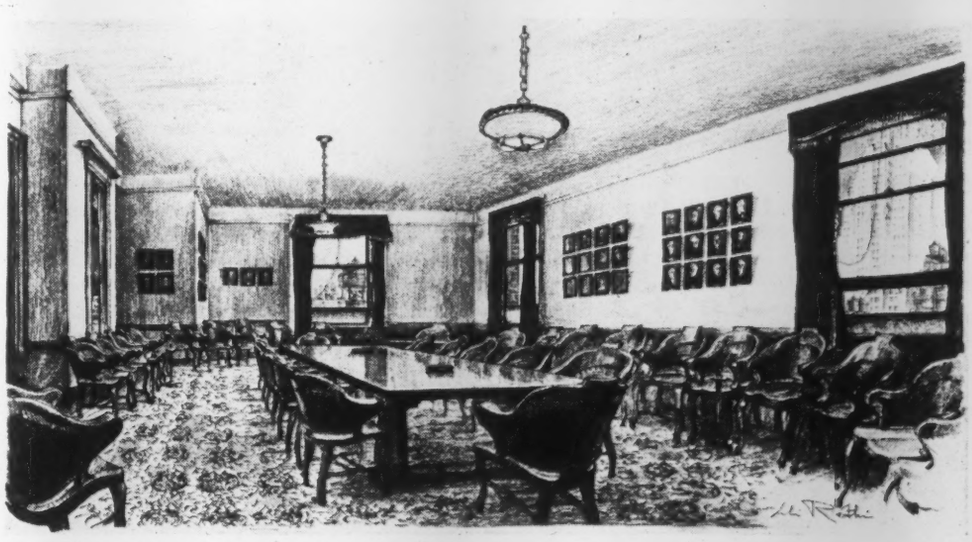
In order to facilitate and coordinate the work of administration of professional-division affairs, these divisions are divided into five general departments and each of the five members of the Committee on Professional Divisions is assigned to advise, assist, and represent on the committee the divisions comprising one of these departments. The departments and the divisions of which they are composed are as follows: Basic Science Department: Applied Mechanics and Hydraulic divisions and Heat Transfer Group; Power Department: Fuels, Power, and Oil and Gas Power divisions; Manufacturing Department: Graphic Arts, Iron and Steel, Machine Shop Practice, Materials Handling, Petroleum, Process Industries, Textile, and Wood Industries divisions; Management Department: Management Division; Transportation Department: Aeronautic and Railroad divisions. In a succeeding article the work of the divisions will be explained in greater detail.

6000 STUDENT MEMBERS IN 120 BRANCHES PROVIDE A RESERVOIR OF FUTURE A.S.M.E. MEMBERS

A great reservoir of potential A.S.M.E. members exists in the 6000 students who are organized in the 120 A.S.M.E. Student Branches under the supervision of the Committee on Relations With Colleges. Student Branches may be established in any institution whose mechanical-engineering curriculum is accredited by the Engineers' Council for Professional Development. New branches are authorized by the Council on recommendation of the Committee on Relations With Colleges. Each branch conducts its own affairs, subject to the rules and policies of the Society, has its own student officers and committees, and its own "faculty adviser." Each student member receives MECHANICAL ENGINEERING for eight months of the school year.

Annually in the spring ten student-branch conferences are held in various parts of the country for branches in the vicinity. Prizes are offered for the presentation of technical papers. Many branches send student delegates to the Annual Meeting of the Society to take part in special sessions arranged for them. Upon graduation, a student member may apply for junior membership. Provided he is elected and makes payment of his dues within a specified time, the student member is charged no transfer fee upon becoming a junior member.

In a subsequent article on the A.S.M.E. member and his pro-



THE COUNCIL ROOM, A.S.M.E. HEADQUARTERS, NEW YORK, N. Y.
(Portraits of past-presidents of the Society hang on the wall.)

fessional development, the relationship of the student member to the Society will be more fully discussed.

THE SOCIETY HEADQUARTERS IS A BUSY PLACE

It is quite clear that the Secretary of the Society must maintain a headquarters and a staff of assistants to carry on the work of the committees. In common with the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, and the American Institute of Electrical Engineers, the A.S.M.E. occupies as national headquarters the Engineering Societies Building, at 29 West 39th Street, New York, N. Y., administered by their joint agency known as the United Engineering Trustees, Inc. This building, made possible by the munificence of Andrew Carnegie, was built in 1906 and houses many other engineering societies and groups in addition to the four Founder Societies, as the A.S.C.E., A.I.M.E., A.S.M.E., and A.I.E.E. are called. It also contains the Engineering Societies Library, the combined libraries of the Founder Societies, jointly operated by them through the Library Board. These and other joint agencies will be described in a later article.

On the eleventh floor of the Engineering Societies Building are the headquarters of the A.S.M.E. (A stock room and a shipping room are located on the twelfth floor.) Stepping off the elevator, the A.S.M.E. member finds himself in the reception lobby. To the right of this is the Council room, and beyond it the members' room, fitted up with easy chairs and writing desks. Beyond the members' room are the President's room and the Secretary's private office, which immediately adjoins it. The remainder of the floor space is given over to the Secretary's staff which numbers about 70 persons.

Office hours are from 9 to 5, and 9 to 1 on Saturday (only a receptionist is on duty on Saturday). Members are free to use the Society rooms as their headquarters while visiting in New York. Mail may be addressed to them there. Because of the heavy demand for committee meeting rooms, arrangements must be made in advance if headquarters are to be used for such purpose by members. The Council room, the President's room, and an alcove off the lobby are in use almost every day, except in summer, by one or more committees. In the period of one year more than 700 meetings are held in these rooms. No charge is made for the authorized use of these rooms for committee and other meetings. The illustrations which accompany this article are from pencil sketches of the Society rooms made by Lili Réthi.

The Society maintains a Mid-West Office at 205 West Wacker Drive, Chicago, Ill., and a Mid-Continent Office at 211 Midco Building, Tulsa, Okla.

HOW THE SECRETARY'S STAFF IS ORGANIZED

Because the Secretary of the Society is also secretary of all of its committees, he must delegate his authority to a staff of assistants. For this purpose he employs two assistant secretaries, an editor, an advertising manager, and a comptroller. These men, with the Secretary, constitute, for purposes of staff administration, an Administrative Committee. Each of these assistants is head of a department and has a staff which reports directly to him.

Mr. Ernest Hartford, assistant secretary, heads the field department and has a staff numbering at present 11 persons. He and his staff serve directly the following committees: Meetings and Program, Professional Divisions, Local Sections, Relations With Colleges, Admissions, Honors and Awards, Education and Training for the Industries, Medals, Nominating, and Society Development committees. Under his supervision come also A.S.M.E. interests in the National Management Council and the joint (with A.I.M.E.) Committee on Fuel Values. Mr. Hartford's assignments necessitate extensive travel in connection with meetings, sections, and student branches.

Mr. Clifford B. Le Page, assistant secretary, is in charge of the technical-committee department and has a staff of six. He and his staff serve the standing committees on Research, Standardization, Power Test Codes, and Safety, and the Boiler Code Committee. They also serve the A.S.M.E. interests in the following joint agencies: American Standards Association, The Engineering Foundation, Center for Safety Education, James A. Holmes Safety Association, U. S. National Committee of the International Electrotechnical Commission, National Fire Waste Council, and National Research Council. The total number of committees which Mr. Le Page and his staff are serving is 502, with a personnel of 2290.

Mr. George A. Stetson, editor, is in charge of the editorial department and has a full-time staff of five persons, assisted by three editors who are on a part-time basis. He serves the Committee on Publications, and its advisory committee on Biography. The department is charged with the editorial work in connection with MECHANICAL ENGINEERING, Transactions, including the *Journal of Applied Mechanics* and the Society Record, the Membership List, and the annual reports of Committees, such special publications as may be authorized by the Council, and miscellaneous programs, circulars, and announcements not handled by other departments. Publicity for the Society is also handled by the editorial department.

Mr. Frederick Lask, advertising manager, is in charge of the advertising and sales department and has a staff of 17 persons. His department solicits advertising for MECHANICAL ENGINEERING and the A.S.M.E. Mechanical Catalog and Directory, and carries out editorial and production work in connection with them, the billing and collections of advertising accounts, and the sale of publications and promotional work in connection therewith.

Mr. D. C. A. Bosworth, comptroller and office manager, prepares the financial reports for the Finance Committee, Treasurer, and the Council. He is responsible for the books of account, the payment of bills properly approved, and the supervision of the general office services of headquarters, including mailing, filing, duplicating, addressing, and like services.

It would seem from the foregoing that the Secretary, C. E. Davies, had nothing left to do but travel about the country, attend banquets, represent the Society at important gatherings, and receive members and other callers. Actually, he has little time for any of these things. He spends much of his time with the President and Treasurer, and travels extensively, visiting local sections and student branches, and in connection with meetings of the Council and the Society.

The principal responsibility of the Secretary is threefold: The first is to carry out the duties laid down in the Constitution and By-Laws (actually in the By-Laws there are 45 references to the responsibility of the Secretary). This involves supervision of the headquarters and administration of the policies and procedures laid down by the Council and the committees. Second, he must keep in touch with the point of view of the members of the Society and present it to the Council and the standing committees. Third, he must be alert to the general problems of the profession through intimate contact with its joint agencies and other engineering societies. He also has responsibilities in connection with public relations and, in addition to the Council, he serves the dozen or so special and standing committees.

In succeeding articles the major activities of the Society will be described in greater detail. For a list of Society committees and personnel, attention is directed to the Society Record-I, an annual supplement to the February issue of Transactions.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Day by Day

AT THE moment of writing, uncertainty of the immediate future is the characteristic that stands out most prominently for the record. The "lightning war" in Poland has been decided in favor of a fast moving mechanized army. The question mark of Soviet Russia looms larger than ever over the European horizon. Troops are massed behind the heavily fortified frontier between France and Germany where there is a greater equality of mechanized offensive and skillfully engineered defensive arrangements than existed in Poland, a situation that makes attack from either side unbelievably costly and hazardous. Neutrals in the "line of fire" are fully mobilized and alert, while those engaging in maritime trade suffer casualties from mine and torpedo. The cities of the belligerents are in war dress, apprehensive, blacked out at night. No major air encounters or bombing raids have taken place in the West, in spite of the fact that sudden destruction of cities was supposed to herald the outbreak of war. The combatants talk peace but prepare for a long war in which economic factors and mechanization will probably play even more important parts than they did a quarter of a century ago. The propaganda front appears to be the most active, yet behind the diplomatic scenes there must be activity enough in arriving at the decisions that all governments, neutral or otherwise, major powers or dependent states though they may be, must make. In this country neutrality, credit, and embargo problems engage the attention of the Congress; and a sensitive stock market guesses one day that some sort of a peace is to be arranged, and the next that a long exhausting war is in prospect. It may well be that before this issue is in the mail some of this uncertainty will be clarified, but no matter what course events may take, toward early settlement or toward a long costly war, the adjustments necessary will be severe and disrupting. The one bright factor is that applied science, that has made war so terrible and its effects so widespread, will also be the best servant of whatever nation or ideology of social and economic life uses it most intelligently.

From whatever cause, and no one doubts that war is a compelling one, indexes of commercial and industrial activity are so positively upward that a business boom is in the making. Factories are busy, inventories are being increased, unemployment is diminishing, and were the causes not associated with preparations for war an era of prosperity might be in sight. Disruption of world trade and the closing to this country of normal sources of essential raw materials should quicken the activities of research workers to use these precious commodities more economically, to find substitutes for them, and to sharpen the wits of those who depend on such materials and of those who provide them, all of which means work for engineers in fields they most enjoy serving. An engineering society thus finds itself more than ever of service as a means of making available to one group what another has discovered and accelerating the incorporation of new knowledge not only in the fields for which it was developed but in others where its application is not so obviously useful.

Not only in the fields of applied science, of materials, of machines, and of the production and use of power does this opportunity for engineers lie, but also in those where the management of industrial productive enterprises is concerned, the techniques of production, operation, and transportation, and the handling of labor problems and relations with the public. In a world engaged in a titanic struggle not only for power, for land, for markets and sources of materials, but for a way of life as well, an engineering society must take thought of nontechnical and nonmaterial factors if it would assist in developing a body of men who are more than slaves or hirelings. To this broad program, even in the midst of most pressing needs to develop technology along specific lines, this magazine is devoted.

Rubber

Most of the uses to which man has put nature's gifts from her vegetable kingdom are of ancient origin and, to us at least, they have been fairly obvious uses. Wood as a structural material, for example, textiles from fibers, paper, straw for the roof thatch—none of these involved any more technology in its use than untutored craftsmen could supply and all have served mankind importantly and well. Of ancient origin, too, is the use of pitch; in building the Ark Noah was told to "pitch it within and without with pitch." But when man once began to turn his trained intelligence to the problem of modifying the properties of these natural materials to improve some and eliminate others, and to making use of the materials themselves as the basis from which to build up entirely new ones, new frontiers were opened up for unpredictable expansion. For centuries men had tanned hides to make leather, but it remained for Charles Goodyear, in 1839, to "tan" rubber so that it would not be too soft for use in summer, or too rigid for use in winter. In so doing he laid the basis for an industry upon which perhaps more than on any other the automobile depends, and one that every year finds new fields to invade.

In commemoration of this significant discovery various celebrations and scientific meetings have taken place during the year. Thus the October issue of *Industrial and Engineering Chemistry* devotes many of its pages to articles on the development of the rubber industry, including addresses by P. W. Litchfield, of the Goodyear Tire and Rubber Company, President Compton of M.I.T., President Conant of Harvard, and papers on Goodyear, who developed vulcanization, Thomas Hancock, who made the first rubber masticator, the process of vulcanization, and a review of the industry from 1839–1939. Engineers will find the articles instructive reading and will be impressed with the words of Pasteur with which Dr. Compton concluded his address: "In our century science is the soul of the prosperity of nations and the living source of all progress.

Undoubtedly the tiring discussions of politics seem to be our guide. Empty appearances! What really leads us forward is a few scientific discoveries and their application."

Hard-Chromium Plating

METAL INDUSTRY

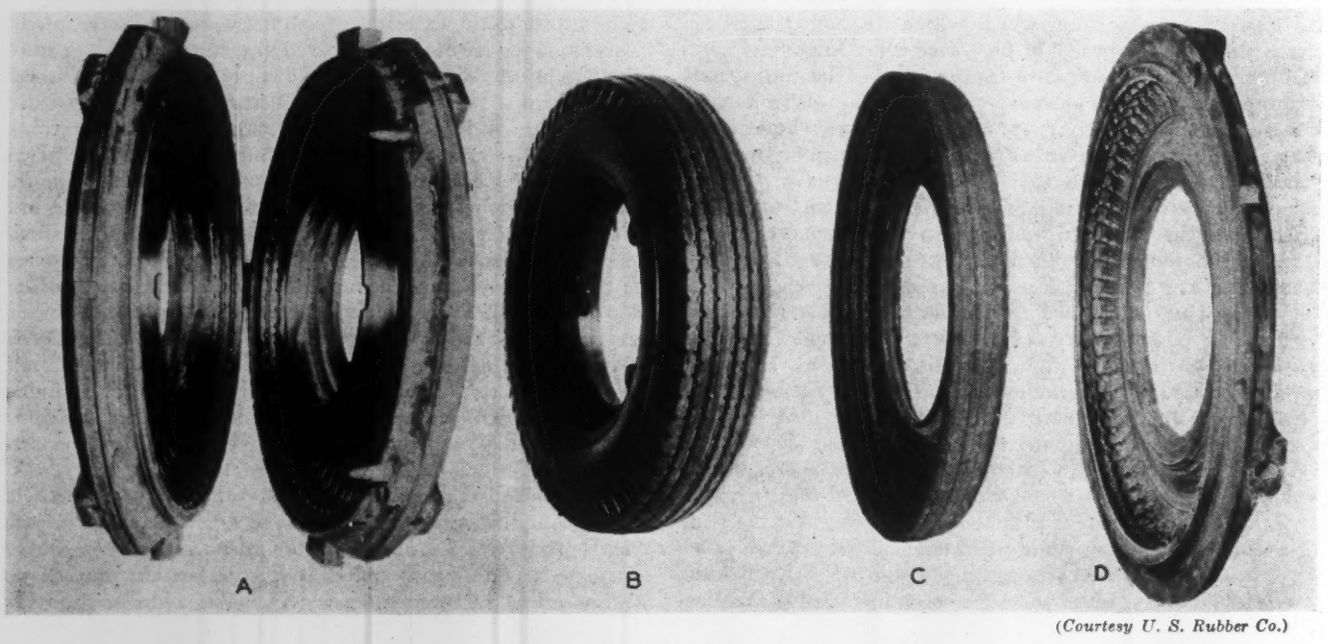
HARD chromium is entirely different from decorative chromium in nature and, according to a description of the process by R. M. Goodsell in *Metal Industry* for September, 1939, is always plated directly upon the base metal, which is most frequently, steel. It is of two kinds, one known as flash plating, the other heavy or specification plating. Flash plating is of a thickness up to approximately 0.0005 in. (Decorative plating is of the order of 0.00002 in.) Flash plating is not usually finished by grinding or lapping to size afterward. Heavy plating differs only by being thicker. The preparatory cost is the same for both.

Deposited upon base metals, hard chromium will withstand high temperatures, as its melting point is 3326 F. It is resistant to corrosion by ammonia vapor, hydrogen sulphide, and all acids except hydrochloric and dilute sulphuric acid. It is not immune to chlorine products, or processes in which chlorine of any quantity is used. The hardness of chromium varies greatly with the conditions of deposition. However, the hardness obtained by electrodeposition is far greater than that attained by any treatment of the solid metal by metallurgical processes, and may vary from 400 to 950 Brinell hardness numbers. This hardness of chromium is due probably to the fine grain size and the condition of strain of the crystal lattices. The presence of hydrogen has some influence on the hardness, but European metallurgists have shown that most of the extreme hardness of chromium is maintained even after almost all of the hydrogen, dissolved in the lattice, has been expelled.

Experience has shown that hard-plated tools and gages will withstand abuse and wear for an exceptional length of time, and surfaces that have been plated with hard chromium are readily finished to a high degree of smoothness by grinding and lapping. While the hydrogen that might be included in the deposit might cause difficulties in final grinding and lapping, there is a remedy that can be employed, and that is to subject the part to a temperature of 570 F, which tends to expel the hydrogen in the deposit. This process does not take away any of the hardness or value of the hard-chromium plate. This method is being used to salvage tools, machine parts, and other objects which otherwise might be relegated to the scrap heap.

Various tests have been made of the value of hard-chromium plating on tools for cutting, and while some have not shown enough advantage to warrant the cost, other tools have had their life more than tripled. The latter include drills, reamers, taps, milling cutters, mills, counterboring tools, and forming tools of various designs, such as are used on turret lathes and on automatic machines. Some of the cutting tools are being used to cut ferrous and nonferrous metals, such as cast iron, malleable iron, mild steel, brass, copper, aluminum, and die-cast zinc. They are also used in the cutting of materials such as bakelite, hard rubber, wood, marble, plastics, and slate.

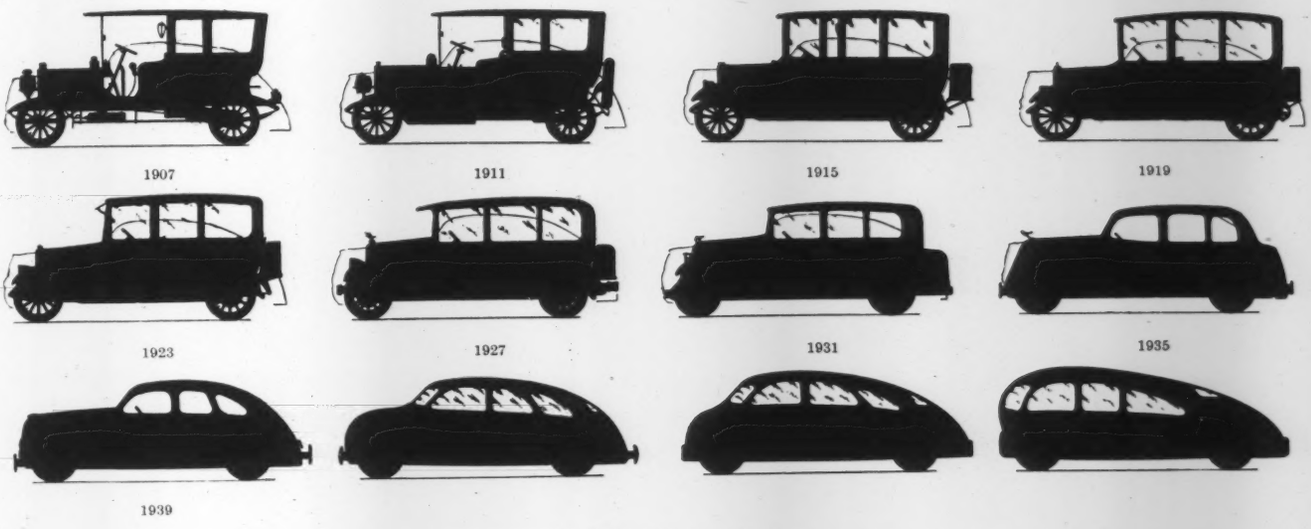
Parts plated with chromium for resistance to abrasion, corrosion, friction, and wear are being used on many types of machines, including lathe-carriage vees, feed screws, gibs, slides, gears, bushings, shafts, pumps for gases, liquids, and semisolids, pneumatic tools, airplane engines, canmaking and filling machinery, cereal-processing equipment, and machines used in the tobacco and leather-working industries.



(Courtesy U. S. Rubber Co.)

ELECTROFORMING TIRE MOLD OF IRON BY EKKO PROCESS

(Electroforming is the same as electroplating except that deposits up to $^1/_2$ in. thick are produced instead of the 0.001 to 0.002 in. of metal applied by electroplating processes. When the heavy electroformed deposit of iron is separated from the underlying pattern of rubber, wood, glass, plastics, or any metal except zinc and aluminum, a cavity or die insert is obtained on which is reproduced the shape and surface finish of the pattern in every detail. This cavity or die when properly mounted may be used to mold or stamp objects the exact shape of the original pattern. In the illustration, *A* is a tire mold made by the usual process of engraving where the tread design and cavity are cut out of a steel forging with special engraving machines and then mounted in the cast-iron backs called watchcases; *B* is a rubber pattern which is rendered conductive by dusting with powdered graphite and then polishing vigorously with a brush; *C* is half of the electroformed shell of iron which is $^3/_8$ in. thick; and *D* is half of a tire mold ready to use after the electroformed shell has been machined to fit in the watchcase back in which it is held in place by welds placed at a few points.)



THE EVOLUTION OF THE AUTOMOBILE BODY

(From *The Automobile Engineer* comes this "automobile show" in which is traced the development of the "horseless carriage" at four-year intervals from 1907 to the present and on into the world of tomorrow.)

The use of chromium in forming and drawing dies will increase their life, assure accuracy, and eliminate draw marks and metal build-up on close work. Chromium-plated dies for drawing wire and tubing have given excellent results because of a better finish, and elimination of the tendency of scale or chips to cling to the dies and mar the surface of the product.

Two steel surfaces sliding together with considerable contact pressure develop tremendous friction. If one of the pieces has a babbitted surface, friction is reduced to a great extent. Yet a chromium surface rubbing on chromium has a friction loss only one half that of the steel on babbitt. Chromium plate in the form of hard chromium meets severe wearing conditions with those twofold characteristics, exceptional hardness and a low coefficient of friction.

Electric Ear Checks Machines

MACHINE DESIGN

FLAWS in running machinery can now be detected by an "electric ear." This device, called an industrial noise analyzer and described in *Machine Design* for September, 1939, measures the intensity of sound at any preselected pitch without picking up any other factory noise. Should there be any variation from the normal sound-frequency intensities (revealed in previous tests), the instrument warns the operator that his machine is defective and may "freeze up" or break down.

To manufacturers of assembly-line products, which heretofore have been tested by ear, this device will also be of great value. A manufacturer of canned liquid foods, for instance, found that in sealing the cans an occasional pellet of lead solder would fall into the mixture and bring complaints from customers. A special type of "electric ear" was developed for him which would pick up only the frequency of the sound of the lead pellet rattling in a can. Attached to the production line, the device dropped out all cans which betrayed the telltale sound.

The analyzer consists of three parts: First, a microphone which converts the noise produced by the product under test into electrical impulses; second, the electrical wave filters which pass from the microphone to the amplifier only the frequency bands of the squeals or hums which occur when a faulty product is tested; and third, the amplifier and the meter which gives a visual indication of the power level in the band being passed. If the meter reading varies from the normal, a defect is indicated. This makes it possible for even the most unskilled worker to detect defects by just watching the dial of the instrument.

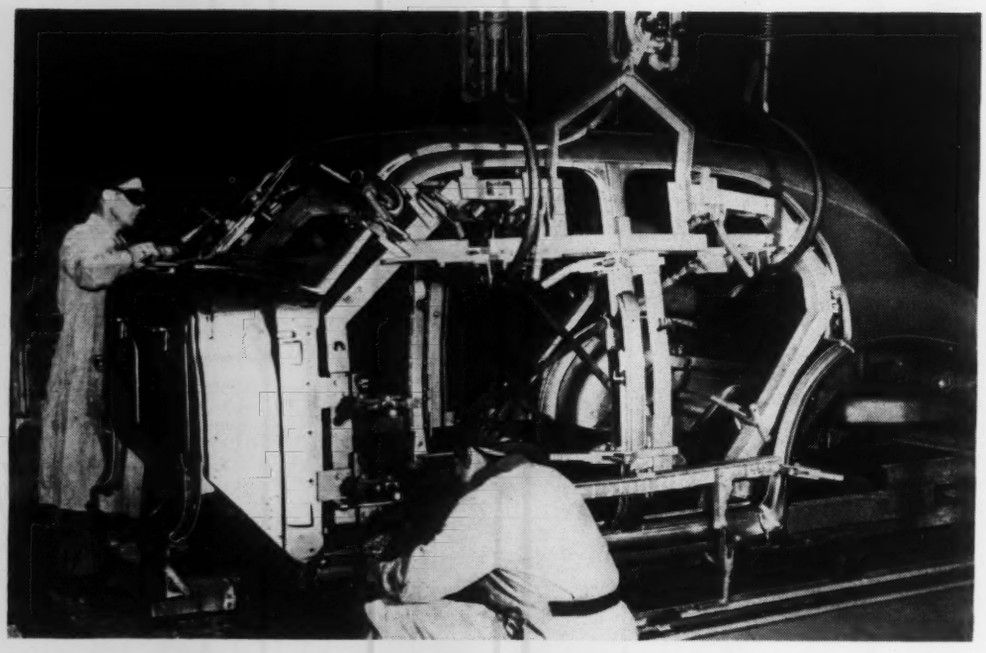
Diesel Fuel Ignition Quality

THE PENNSYLVANIA STATE COLLEGE ENGINEERING EXPERIMENT STATION

IGNITION quality is defined by Jasper S. Chandler in The Pennsylvania State College Engineering Experiment Station Bulletin No. 47, entitled "Ignition-Quality Rating of Diesel Fuels by Commercial Engines," as that property of Diesel fuels which makes for easy starting, low audible knock, and relatively vibration-free running. It is readily seen, says Mr. Chandler, that ignition quality, along with other fuel properties, is of practical utility to both the oil producer and the user. The greater use of small, high-speed Diesels, which are more sensitive to ignition quality, increases the importance of this property. It remains only to find a suitable, accurate, and representative method of determining ignition quality.

Since ignition cannot be measured directly in physical units, such as mass or temperature, but is manifest only in its effect upon an engine, there is need for a definite yardstick for its measurement. The specification of a measurable effect upon the engine leads to difficulty because this varies greatly with engine design and operating conditions. Rather, the specification is on the basis of a standard reference fuel which will produce the same engine effect as the test fuel when both are tested under identical conditions. In this country, the accepted primary fuels are made up of blends of cetane ($C_{16}H_{34}$), which has a high ignition quality, and alpha-methylnaphthalene ($C_{11}H_{10}$), which has a low ignition quality. The percentage by volume of cetane in the blend is the cetane number. For economy, secondary reference fuels calibrated against the primary standards are usually used for routine testing. A commonly used secondary series is made by mixing a high cetane fuel, referred to as dupo, with commercial methylnaphthalene.

The author made correlation tests with seven fuels on nine



JIGS ASSIST IN WELDING OF 1940 AUTOMOBILE BODY

(Welders fuse steel to steel in joining the three major subassemblies of a General Motors 1940 automobile body. Perfect alignment is assured by the jigs in the door openings and the removable cross braces that resist the expansion and contraction of the steel as it heats and cools in the fusing operation.)

commercial engines of various types and sizes and in his report compares the results obtained with the ratings of the same fuels determined by the Cooperative Fuel Research (CFR) engine. His more important conclusions are contained in the following summary. He states that the CFR laboratory method underrates the fuels by an average of 3 cetane numbers, relative to the commercial engines. Comparison of the different commercial-engine ratings among themselves shows that the average deviation is 2.8 dupo numbers (1.56 cetane numbers). The accuracy of rating is about the same for both the required-compression-ratio and the air-intake throttling methods. The accuracy of the variable-ignition-lag method is much poorer for the higher-ignition-quality fuels. The engine type apparently has a greater effect on the ratings than the particular method used. The ratings by the air-intake throttling method agree reasonably well both with the required-compression-ratio ratings and the variable-lag ratings when they are compared for the same engine.

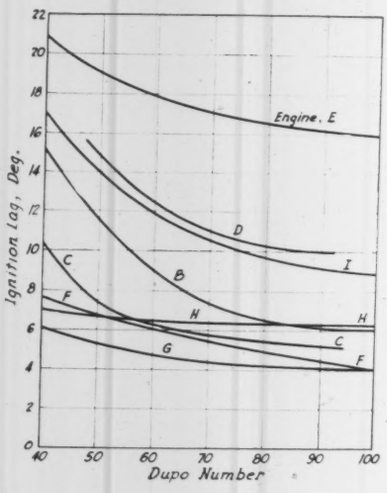


FIG. 1 COMBINED IGNITION-LAG CURVES OF VARIOUS DIESEL ENGINES

Commercial engines may be compared by noting the slope of the ignition-lag versus ignition-quality curves. Engines *B*, *D*, and *I* have the steepest curves, as shown in Fig. 1, indicating their suitability as test engines. Engines *H* and *G* have the flattest curves, indicating that they are less sensitive to changes in ignition quality of the fuels; this is an advantage in service engines.

The slopes of these curves at the 70 dupo point are tabulated in Table 1. Still another basis of rating engines is the regularity of the ignition lag. For this purpose the average deviation of the ignition lag from the mean lag in terms of degrees for all fuels is also given in Table 1.

Flameproof Diesels for Mines

THE IRON AND COAL TRADES REVIEW (GREAT BRITAIN)

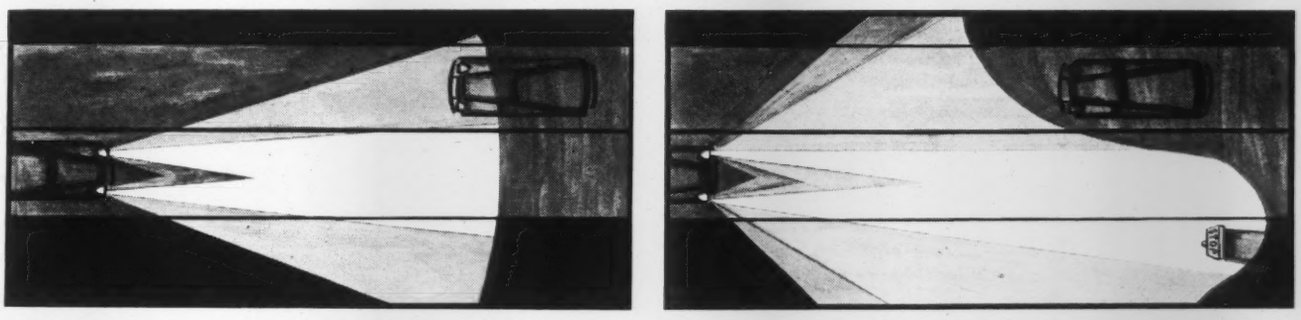
DIESEL locomotives have been used safely in mines for many years in Germany, Belgium, and France, but it is only recently that their use has been permitted in British mines and places where inflammable and explosive materials are manufactured and stored. This has been made possible with the development of an exhaust-gas conditioner and spark and flame arrester which is described in the Sept. 8, 1939, issue of *The Iron and Coal Trades Review*.

On the exhaust side of the Diesel engine, the gases first pass through a nonreturn valve into the exhaust-gas conditioner,

TABLE 1 DIESEL-ENGINE COMPARISON DATA

	Engine								
	B	*C*	*D*	*E*	*F*	*G*	*H*	*I*	Average
Average differences of all fuels, dupo no.[a]	+3.27	+5.32	+6.99	...	+2.77	+3.41	...	+2.13	+4.00
Slope of calibration curve at D70, deg per dupo no.	0.113	0.042	0.103	0.068	0.058	0.027	0.010	0.100	0.065
Average deviation of ignition lag from the mean lag (all fuels), deg	0.14[b]	0.280	0.10[b]	0.790	0.132	0.107	0.083	0.06[b]	0.212
Average deviation of readings converted into dupo no.	1.28	3.5[b]	0.99	9.9[b]	2.2[b]	2.4[b]	4.15[b]	0.57	3.12[b]

[a] Conversion factor: cetane number = 0.74 × dupo number.
[b] Computed on the basis of the ignition-lag gradient at 50 cetane numbers.



1940 AUTOMOBILES FEATURE SEALED-BEAM HEADLIGHTS

(The light patterns cast by former-type lamps and the new sealed-beam lamps are compared in these illustrations. Combining reflector, light source, and lens in one tightly sealed unit, the new lamp is the result of three years' cooperative research by the entire automobile industry. It is protected against dust and other foreign material which cut down the reflector's efficiency, and with its focus permanently fixed at time of installation, it will not only have a longer, more effective life but, properly used by the driver, will provide greater freedom from glare than the prior types of headlamp.)

shown in Fig. 2, from which the gases pass through flame arresters into an air-mixing chamber, when they are mixed with 30 to 40 times their volume of fresh air before being exhausted into the ventilating current. The complete conditioner, including cover plates, internal baffles, and other parts, is manufactured of rustless steel in order to combat the highly corrosive nature of the water in the conditioner. Furthermore, automatic equipment has been fitted so that in the event of the water level being allowed to fall below a certain level, the fuel is automatically cut off from the engine and at the same time the locomotive and train brakes are automatically applied.

During the development stages there was considerable difficulty due to clogging of the exhaust-flame arresters which created back pressure on the engine. Sometimes this took place within an hour of the starting up of the engine. A redesign of the internal structure of the conditioner and the method in which the exhaust gases were made to enter the flame-arresters

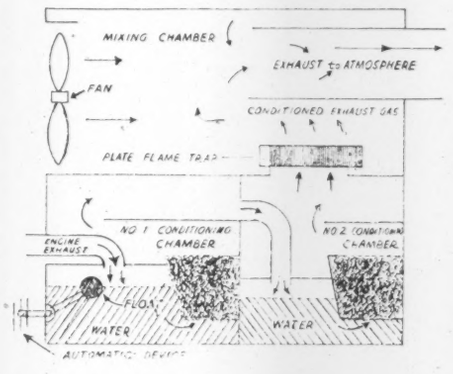


FIG. 2 EXHAUST-GAS CONDITIONER AND FLAME ARRESTER FOR DIESEL LOCOMOTIVE

has, however, overcome these troubles, and today the routine arrangement is to change the arresters on the exhaust side every shift. Complete spare arresters are supplied with the locomotive for this purpose. The design permits the plates to be separated, easily cleaned, and reassembled.

On the inlet side of the Diesel engine, the air is passed through an air cleaner and then through a flame arrester. All parts of this flame arrester, including body and cap, cover plates, as well as the flame plates themselves, are made of rustless steel, and the whole unit is interchangeable in every way with the exhaust flame arresters.

Pumpless Injection for Diesels

AUTOMOBILE ENGINEER

NOT long ago Dr. Ing. Prosper L'Orange, of Stuttgart, Germany, recently deceased, delivered a lecture in Karlsruhe on "The Development of the Small High-Speed Diesel Engine Without Injection Pump." The abstract, which follows, is taken from an article, based on the lecture, in the *Automobile Engineer* (Great Britain) for September, 1939.

It is pointed out that for very small Diesel engines the injection pump and the injection valve must be eliminated, just as the injection compressor had to be discarded years ago. Apart from the practical difficulties connected with the production of very small pumps and injectors, the cost of such equipment becomes increasingly disproportionate and even prohibitive as the size of the engine is reduced. Dr. L'Orange's solution consists in brief of employing the pressure differential between the main combustion space in the working cylinder and an antechamber. The system has been tried out on a 122-cu in. two-stroke engine and also on small two-stroke and four-stroke engines having swept volumes of 6 to 18 cu in.

From a section of the four-stroke engine cylinder head, Fig. 3, it will be seen that the fuel is admitted on the suction stroke by a mechanically operated needle valve *A* actuated by a small rocker *B* and a push rod from the normal overhead rocker for the air valve. The quantity of fuel delivered is regulated by varying the lift of the needle by means of the eccentric rocker shaft *C*. In the inserted block in which the needle is seated the throat *D* is formed which establishes communication between the main combustion space and the antechamber. Fuel is not admitted directly but to a delivery channel *E* provided with small exit channels *F* leading into the ends of the restricted throat. A thermally loaded heat-storage member *G* is provided in the antechamber and a heater plug is fitted to insure starting in a cold condition.

The pressure difference between the ends of the two exit channels carries the fuel from the delivery channel to the antechamber and to the main combustion space at different stages of the working cycle. This is shown in detail at the bottom of Fig. 3. In 1 the delivery channel is clear of fuel after combustion has been completed, while in 2 the fuel enters the delivery channel on the suction stroke of the engine. During the compression stroke fuel is forced into the antechamber, as in 3, but when combustion commences in the antechamber with a rise in pressure the flow is reversed and, as in 4, the remaining fuel is delivered into the main combustion space.

The method of governing will differ from that of the normal

pump-injection system in which the tendency is toward a surplus of fuel at high speeds and a relative paucity of fuel at the lower speed range. In the L'Orange fuel-injection system

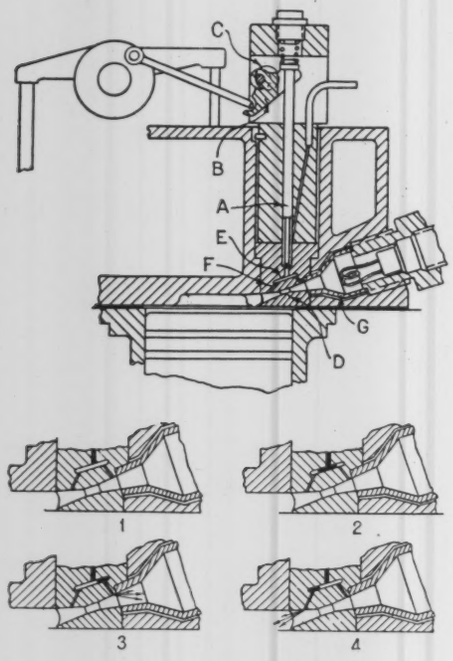


FIG. 3 DETAILS OF L'ORANGE FUEL-INJECTION SYSTEM FOR SMALL DIESEL ENGINES

these conditions do not apply. As before, when speed is increased the volumetric efficiency of the engine will be lowered, but instead of more fuel being supplied by a pump, less will be drawn in on the suction stroke.

Voith-Schneider Ship Propeller

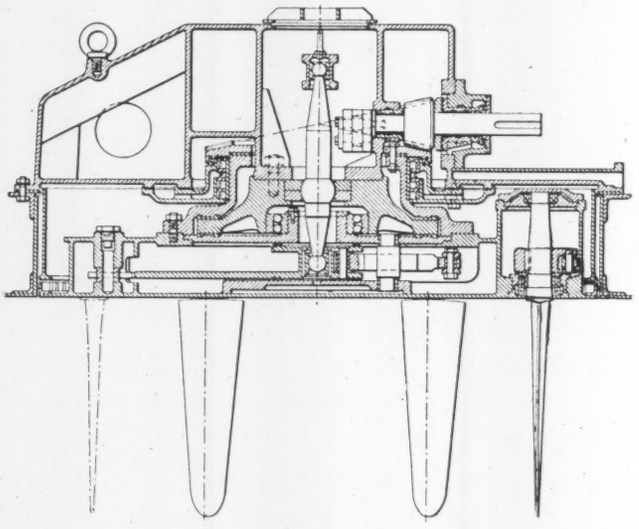
ENGINEERING

SINCE the first Voith-Schneider propeller was fitted and demonstrated in a launch in 1929, more than 100 ships have been fitted with these propellers which may be driven by steam or Diesel engines or electric motors. According to a paper by E. C. Goldsworthy, prepared for presentation before the canceled meeting of the British Association for the Advancement of Science, September, 1939, and appearing in *Engineering* for Sept. 15, 1939, the results of the first installation proved beyond any doubt that a third system of propulsion had been added to the paddle and screw for mechanically powered ships.

The present type of Voith-Schneider propeller, shown in Fig. 4, consists of a number of vertical blades of airfoil section rotating in the horizontal plane. These blades are spaced symmetrically about a rotating disk or runner wheel in an opening in the hull bottom and flush with the latter. The blades can be made to perform a swinging motion around their axis and the law governing the blade movement is shown in Fig. 5. The normals to all the blade profile must, at all times, intersect at a point N within the blade orbit, this point being off-center transversely to the thrust direction. The farther the point N is moved, the greater the pitch of the blades, and consequently, the thrust, up to the limit at which full power is developed. If the point N is at dead center the blades will revolve and give no thrust, but with an increase of thrust the ship's speed will increase without any change in the speed of the engines. It is important to note, therefore, that the Voith-Schneider propeller is of variable pitch. By moving point N to the opposite side, through the center and beyond it, a thrust in the opposite direction is given and the blade profiles move in a similar but opposite manner to that for forward thrust, there being still no change in speed or direction of the engine or propeller.

Point N can also be swung round the propeller center, so that the thrust direction can be varied, thereby steering the ship with the propeller and making it possible to swing her without any movement ahead or astern. The Voith-Schneider propeller alone controls the ship's movements, unlike the normal vessel which requires variability of engine speed, reversible engines, and rudder. With twin propellers, a purely lateral displacement of the ship can be obtained, which is of particular value to floating cranes and other such craft.

The normals to the blade profiles which intersect at N are, in practice, replaced by a linkage, shown in Fig. 4, so designed that a relatively small displacement of the control disk will correspond to a large eccentricity of the point N. The arrangement of the two pressure-oil servomotors, by which the blade mo-



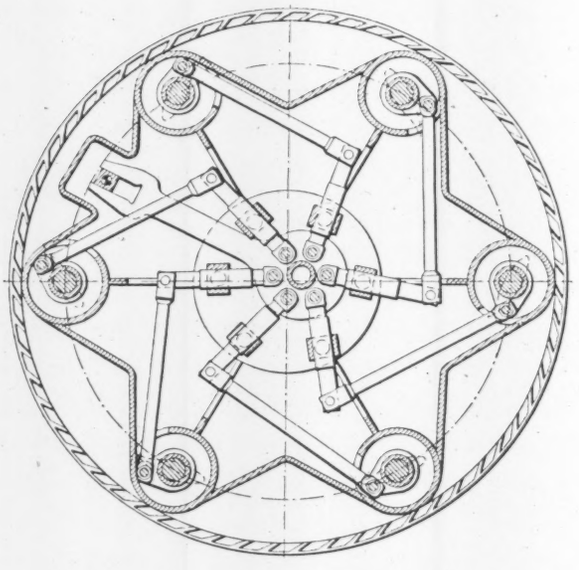


FIG. 4 MECHANICAL FEATURES OF THE VOITH-SCHNEIDER MARINE PROPELLER

tion is controlled, is shown in Fig. 6. These servomotors act on the upper end, N', of a double lever, the lower end of which moves the control disk of the blade linkage. The point N can be universally displaced within the outline of an approximate square, and will give all the required variations of speed and thrust direction. At full speed ahead (N at A), the blade position can be altered by about 40 deg, allowing sharp turns to starboard, B, or port, C. If N' is at D or E, the ship has no speed of advance, but a rudder angle of 90 deg, and turns, with full power, on the spot. The speed servomotor is controlled from a lever on the bridge and the steering servomotor from a small handwheel, also on the bridge. This arrangement is similar to that used for control of screw-propelled vessels.

The mechanical features of the propeller are shown in section in Fig. 4. The pinion shaft (above propeller on right of center) has self-aligning bearings, and on this shaft, operated by a chain, is the oil pump supplying the servomotors at a relatively high pressure of between 160–280 psi, depending upon the size of the installation and a pressure between 10 and 30 psi on the lubricating system. The oil system is totally enclosed, the propeller housing being filled with oil to the underside of the main roller bearing and connected with discharge and suction pipes to an oil tank situated alongside the propeller. Oil channels are fitted, running to all the bearing parts located above the oil level, so that a constant supply of oil is present as soon as the propeller starts up. The motion of the horizontal shaft is translated to the vertical drive through a spiral-bevel gear, and such gears are suitable up to powers of, perhaps,

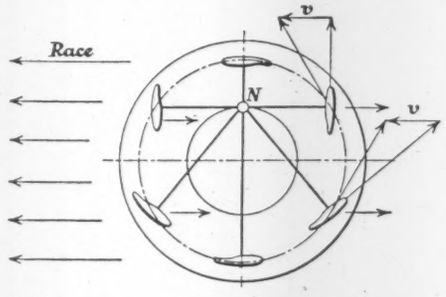


FIG. 5 THEORETICAL FEATURES OF THE VOITH-SCHNEIDER MARINE PROPELLER

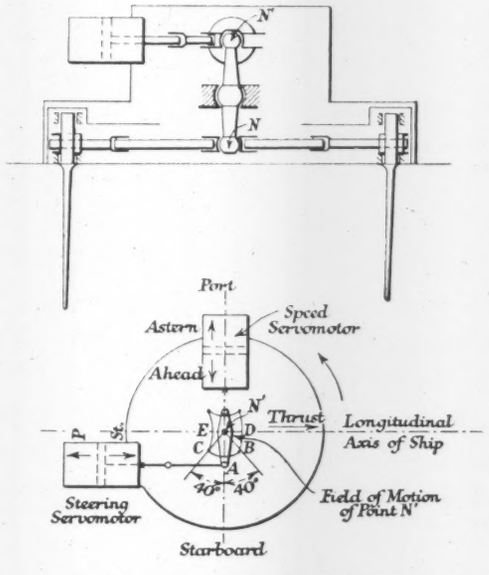


FIG. 6 ARRANGEMENT OF SPEED AND STEERING CONTROLS OF VOITH-SCHNEIDER PROPELLER

3000 to 4000 hp. Above these limits it is necessary to employ electric drive with the motor placed directly above the propeller. The great advantage here is that alternating current can be used, since the propeller is of constant speed, thus giving simplicity of control gear and reducing first cost.

Rotative Boiler Turbine

ZEITSCHRIFT DES VEREINES DEUTSCHER INGENIEURE

A ROTATIVE boiler turbine, which combines a steam generator with an air heater and fan, and a steam turbine with condenser, in one compact unit having a rating of 100 kw is shown in Fig. 7. Designed and built by Fritz Hüttner,

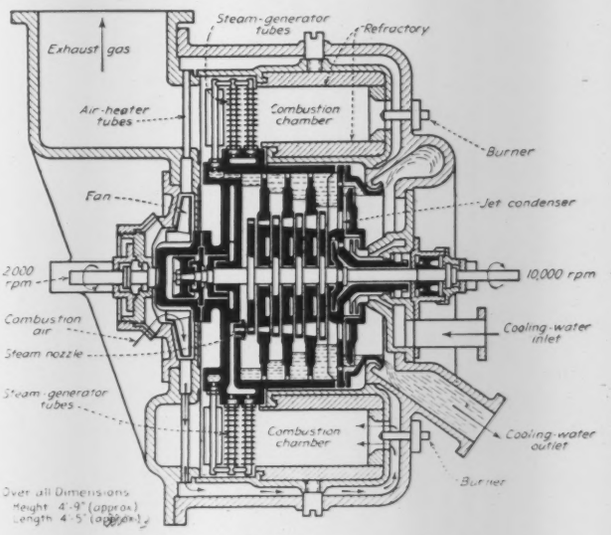


FIG. 7 CROSS-SECTIONAL VIEW OF HÜTTNER 100-KW ROTATIVE BOILER TURBINE

of Berlin, it is described by him in a paper which appears in the *Zeitschrift des Vereines deutscher Ingenieure*, April 8, 1939, and is published in abstract form in *Power* for September, 1939.

The burners, using either liquid or gaseous fuels, are arranged in a circle and fire into a refractory-lined combustion chamber. At the open end of the stationary combustion chambers are several radially arranged and rotating U-tubes, some having concentric fins to enlarge the heat-transmitting surface and others with volute fins to assist the movement of the combustion gases by centrifugal pump action. In each U-tube, the ends of which are connected by ring-shaped collectors, a state of equilibrium establishes itself between the water and steam column since the water level varies with circumferential speed, which in turn depends on the steam pressure generated.

The steam flows into a collecting chamber from which it passes through a circle of nozzles directly into the turbine. The boiler rotates in a direction opposite to that of the turbine disks. A jet arrangement condenses exhaust steam within the turbine housing. Incoming cooling water, introduced near the axis of rotation, corresponds at all times to the volume of steam used, excess water flowing over the rim of the water chamber and the condensate going back into the steam-generating tubes.

There are no auxiliaries except an electric starting motor to bring the unit up to about 10 per cent of operating speed. Average steaming capacity has been found to amount to 50 lb per sq ft per hr. Space requirements for the complete unit are

said to be comparable to those of an electric motor of the same output. The boiler automatically drains its water content when the unit is stopped. It is claimed by the author that in a range of pressures of 300–700 psi and with turbine efficiencies of 75–80 per cent and boiler efficiencies of 85–88 per cent, overall thermal efficiencies of 22–28 per cent may be obtained.

This Modern Age of Plastics

MODERN PLASTICS

THAT plastics have finally come into their own in industry is evidenced by the October, 1939, 454-page issue of *Modern Plastics*, which contains many descriptive articles about the 14 major types of plastic materials, from alkyd to vinyl, that are available today, a chart comparing the physical characteristics of these materials, and a directory-catalog section listing hundreds of manufacturers of plastics and plastic-fabricating machinery. As a further indication of the potential uses for plastics, the cover of this particular issue is made up of a thin mahogany veneer impregnated with a resin which bonds it to the underlying fabric base, making it a laminated plastic cover.

In order to point out just how broadly plastics serve requirements both in industrial and commonplace applications, the editors of the magazine have devoted a section to a series of brief articles, profusely illustrated, about the development of all kinds of products from plastics. Industry, naturally, consumes a great quantity of plastic products as well as producing them for consumer use. Laminated plastics, because of their ability to resist wear, abrasion, and moisture, are used as gears. They are quiet in operation, may be lubricated with water, and possess many attributes which recommend them to such service. Plastic materials are also used as extremely efficient insulation. Transparency and resistance to grease and oils make certain plastics desirable for electrical and mechanical uses.

Since the turn of the century when celluloid wind and rain curtains first darkened the interior of the horseless carriage, plastics in one form or another have found increasing usage in the manufacture of motor vehicles. Through laminated gears, they provide noiseless and trouble-free timing mechanism. And through modern methods of molding- and automatic finishing operations, they contribute to the electrical, mechanical, and decorative perfection of the present-day automobile.

Fountain pens, card-index boxes, dictaphone and typewriter parts, calendars, ash trays, and desk memoranda boxes of plastic material are familiar equipment in any modern office. Telephones, of course, are made of molded phenolics and acetates and have been for a long time. Typewriter and adding-machine keys are invariably made of plastics, usually injection-molded of cellulose-acetate compound. More recently, however, business machines have appeared in businesslike plastic housings which give them a smart, efficient appearance with a surface that remains unscratched through years of service.

There are many places in the home where plastics have become indispensable. They have replaced other materials which rendered less permanent service and at the same time, they have improved the appearance of commonplace things by providing cheerful color and a lasting surface which doesn't chip, dent, or wear off. Radios, for example, with reception qualities of higher-priced sets, have been made available at low cost because their housings are molded from plastic materials. Ash trays, brushes of every sort, lamp shades and reflectors, clocks, colored telephones, sewing baskets, transparent containers for hats and gloves, door knobs, and cabinet hardware all benefit through continued research and perfection of plastic-molding compounds of one type or another.

Weight of Stored Energy

PRODUCT ENGINEERING

AN ARTICLE by Vernon H. Grant, Bureau of Aeronautics, Navy Department, appearing in *Product Engineering* for September, 1939, attempts to evaluate the various forms of stored energy in terms of weight in connection with the study of auxiliary power in airplanes. The author says that suggestions often advanced involving energy storage, while possibly not completely fantastic, are still so far from the optimum designs obtainable that a fresh start, based upon more sound concepts of relative weights, is usually necessary. It is with the latter object in mind that he has studied the different sources of power and compiled the following table in terms of the electrical unit pounds per kilowatthour, since electricity is usually considered as the primary means for distributing auxiliary power.

WEIGHT-ENERGY CONVERSION FACTORS

Type	Weight, lb per kwhr	Container weight, lb per kwhr	Total weight, lb per kwhr
Gasoline	0.18	0.02	0.20
H_2 gas sphere	0.06	1.92	1.98
H_2 gas cylinder	0.06	2.97	3.03
H_2 liquid	0.06	0.12	0.18
Cartridge	2.78	2.78	5.56
Dry battery	45–65	...	45–65
Storage battery (10 hr)	108	...	108
Storage battery (3 min)	480	...	480
Compressed air (100 psi)	281	600[1]	881
Compressed air (500 psi)	204	420[1]	624
Compressed air (1000 psi)	128	273[1]	401
Compressed air (5000 psi)	93	200[1]	293
Flywheel (not including hub and web)	302	...	302
Rubber	1290	...	1290
Steel, tension or compression	147500	...	147500
Steel, spring	443000	...	443000

[1] Container weights based upon spheres, cylinders are $1\frac{1}{3}$ to 2 times as heavy.

Factory Fire Protection

SAFETY RESEARCH INSTITUTE

A NEW system of fire protection has reduced the number of fires by more than 60 per cent in 16 of the largest plants of the Chrysler Corporation. The system depends upon the organization of departmental brigades and the use of first-aid fire-extinguishing equipment, reports the Safety Research Institute. According to the figures of insurance companies, the 1937 fire record of the company showed a 60 per cent decrease over the number of fires experienced in 1934.

Now, at all plants of the company, instead of a single fire department or brigade, trained in the use of large hose and equipment for supplementing the automatic protection, a brigade is organized in each department and trained in the use of the equipment at hand, such as fire extinguishers. Each foreman, under the supervision of the plant fire marshal, organizes, instructs, and leads the fire brigade in his own department. The advantages of this arrangement are that the brigade is always close to the scene of the fire, and the members, being familiar with the fire hazards and fire extinguishers required to cope with those hazards, are able to act instantly in an emergency. Other trained personnel includes all watchmen and plant police.

LETTERS AND COMMENT

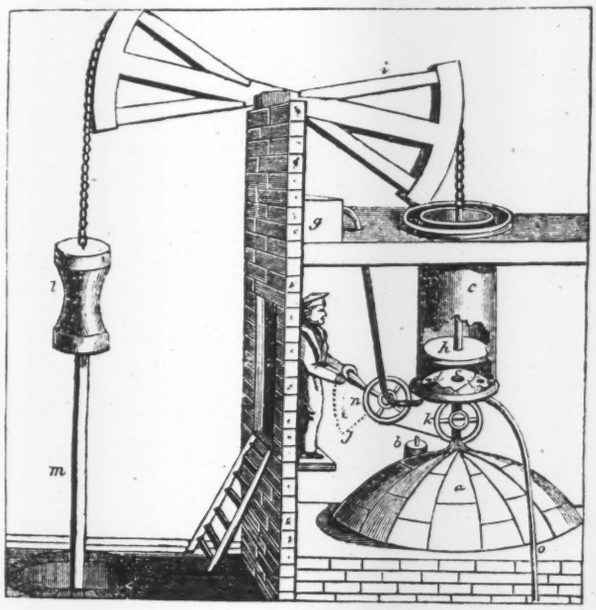
Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Newcomen and Humphrey Potter

To the Editor:

With the 210th anniversary of the passing of Thomas Newcomen duly recognized by The Newcomen Society here in New York last August 5, it is perhaps appropriate that we should again review that first of all commercial steam engines. We therefore submit an early engraving of the Newcomen engine in operation, dated 1720.

The description is taken, in part, from



THOMAS NEWCOMEN'S STEAM ENGINE

(From "History of the Steam Engine," by Elijah Galloway.)

that by Elijah Galloway in 1828. At the base of the cylinder, over the boiler, are seen three holes; that on the left admits a cold-water jet for condensation of the steam; at the right is the exit pipe for the condensed steam and water. The center hole admits steam.

A sufficient quantity of steam is first formed in the boiler when the boy pushes the handle or lever which he holds down to *j*, which, by the wheels and band, opens the cock *k* and allows the steam to enter the cylinder. The steam, being only sufficient to equal the pressure of the atmosphere, will not of itself lift the piston and loggerhead (or beam); it is, therefore, necessary that some means should be adopted to aid it in its ascent. This is done by means of the weight or counterpoise *l*, so that by the force of the steam and gravity of the counterpoise, the piston is elevated to the top of the cylinder, and forces down the pump rod *m* into the pump in the mine. When this is effected, the boy returns the handle to its original position, which prevents the admission of more steam from the boiler and, at the same time, opens the cock *n* so as to admit a small quantity of cold water . . . . . so that a vacuum is obtained, and the pressure of the atmosphere presses down the piston, and thereby raises the pump bucket in the mine . . .

We should also state that the machine was, by no means, so simple as our drawing represents; a number of catches and springs being necessary to obtain the changes of the cocks; the uncertainty arising from the employment of boys was, likewise, a matter of much vexation and inconvenience. This evil, however, produced its own remedy; for a boy named Humphrey Potter, being inclined to scog, or skulk, fastened a cord from the beam to the handle *j*, and a weight to the handle also, by which means the engine itself produced the necessary motion. This he called a "scogger."

The way of the transgressor is hard, as was the boot of the foreman when, to his horror, he observed poor Humphrey Potter's engine operating at twenty strokes a minute instead of the usual eight, and it became harder when he discovered the young skulker. Our hero was ignominiously and literally kicked off the premises.

We would dearly like to know the further history of poor Humphrey, who, at the age of twelve, was vigorously cast into oblivion, when, by his ingenious device, he so ably promoted the rise of steam power.

Cyril G. R. Humphreys.[1]

[1] Consolidated Edison Company of New York, Inc. Mem. A.S.M.E.

A New Type Orchard Heater

To the Editor:

In his paper[2] Mr. Leonard describes a modification of a bowl-type orchard heater that appears to be effective in the elimination of smoke from the stack and soot formation within the heater. The mechanical modifications are ingenious, particularly the balance of the pressures within the operating heater that enables normal circulation of the gases to be practically self-adjusting. Under the heading of "The Use of Diluents to Reduce Smoke Output," the author might have attacked his problem from a chemical point of view. Smoke of course is due to incomplete combustion, or the lack of sufficient oxygen and temperature. The atomization of the fuel is not considered in the case of the bowl-type heater, but in the commercial type of furnaces it is of paramount importance. Should an excess of oxygen be present and smoke still persist, then sufficient temperature has not been provided to raise the vapors to their ignition point. The introduction of preheated diluents such as hot stack gases is one means of raising the temperatures to a degree sufficiently above the ignition point to convert the unburned carbon to nonvisible carbon dioxide. It is believed that the beneficial results secured by the author may be attributed to the use of the preheated stack gases, thereby raising the temperatures above the ignition point of the oil vapors. By this means he eliminates the smoke and also the soot within the heater.

Mr. Leonard briefly refers to the fact that certain oils are more susceptible to the formation of heavy resins and tars than other oils, and expresses a desire to be able by laboratory tests to differentiate between them. This difference which he notes is no doubt that of a so-called straight run, on the one hand, or of a cracked product on the other. The latter oils, by reason of an unsaturated hydrocarbon content, possess the quality of forming the heavy resins under certain conditions. Any such tests as the iodine

[2] "A New-Type Orchard Heater," by A. S. Leonard, Mechanical Engineering, June, 1939, pp. 443–446.

or bromine number, the unsulphonated residue, or the Indiana sludge test would differentiate these oils. However, from an economic point of view, one should desire to be able to utilize the cracked type of oils, instead of to set up standards to eliminate them. A heater having the ability to handle them should experience no difficulty whatsoever in burning the other type, i.e., straight-run oil.

Storage facilities of a distributor may not always provide for the straight-run product, or market demands may place a premium on it, hence the admonition to utilize the cracked product instead of a select grade of fuel. It is the writer's belief that the burner described by Mr. Leonard would handle the cracked fuels better than has heretofore been possible, and that further developments should be along these lines.

C. K. HEWES.[3]

TO THE EDITOR:

Mr. Hewes discusses conditions conducive to the production of smoke and advances an explanation for the beneficial results secured by the author from the use of hot stack gases returned to the bowl of the heater.

Orsat analyses of the stack gases of several combustion-chamber orchard heaters indicate large percentages of excess air throughout most of their ranges of burning rates. At their lower burning rates some readings of over 200 per cent of excess air were obtained while the heaters were giving off considerable quantities of smoke. The smokiness of most of these heaters at high burning rates could not be materially reduced by the addition of more air through increasing the number or size of louvers or air inlets. Under these circumstances, the presence of the smoke cannot be attributed entirely to insufficient oxygen. It seems more probable that the small particles of soot which are formed as the fuel vapors enter the combustion zone do not remain within the combustion zone long enough to become completely consumed by the free oxygen present. They thus escape from the heater in the stack gases in the form of smoke.

Temperature measurements in the bowl and stack gases returning to the bowl indicate that the two are substantially the same at low burning rates while at high burning rates the stack gases may return to the bowl at temperatures as much as 150 F higher than those of the bowl. In any case, the heat that these gases can give out in passing through the bowl is relatively small while in passing through the combustion zone they must absorb relatively large quantities of heat since they enter the bowl at temperatures far below those of the combustion zone. This is apparently substantiated by temperature measurements of the stack gases and combustion-chamber walls. Stack-gas temperatures were found to average about 150 F lower in the Leonard heater than in the Jumbo cone heater and the combustion chamber on the Leonard heater was found to average about 200 F lower.

Recent tests with a slightly modified Leonard heater indicate the susceptibility of the fuel to oxidation is of less importance than was at first thought. Growers are acquiring increased storage facilities so that they will be able to select, purchase, and store during periods of low demand enough fuel to last them through a winter of bad freezes such as the winter of 1936–1937.

A. S. LEONARD.[4]

[3] Chief Chemist, Richfield Oil Corporation, Wilmington, Calif.

[4] California Agricultural Experiment Station, Davis, Calif.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of September 15, 1939, which were subsequently approved by the Council of The American Society of Mechanical Engineers.

CASE NO. 864 (REOPENED)

(Special Ruling)

Inquiry: Will unfired pressure vessels fabricated by fusion welding under the test requirements of Pars. U-69 and U-70 meet the Code provisions if the base metal is a high-strength annealed copper alloy coming within the range of composition covered by either type "A" or "C" copper-silicon alloys as defined in Specification S-36 for copper-silicon alloy plates and sheets, and rods and bars as defined in Specification S-37?

Reply: It is the opinion of the Committee that high-strength annealed copper-alloy plates or sheets having the chemical composition and minimum physical properties specified in the inquiry may be used for the construction of unfired pressure vessels by fusion welding under the general requirements of Pars. U-69 or U-70. For vessels constructed under either paragraph the welding requirements and stress allowances of Par. U-69 are to apply, except that:

(1) The elongation as determined by the free bend test shall be not less than 30 per cent;

(2) The operating temperature shall not exceed 350 F;

(3) Stress relieving is not required; and

(4) The provisions of Pars. U-36 and U-20 and Table U-4 shall apply, and only annealed material having a minimum tensile strength of 50,000 lb per sq in. shall be used.

For the allowable working stresses, see Par. U-20 and Table U-4.

ANNULLED CASES

Case No. 786
Revision of Specification S-4
Case No. 844
Revision of Par. H-78
Case No. 853
Revision of Pars. H-64 and H-117
Case No. 866
Revision of Pars. P-102h and U-68h
Case No. 867
Adoption of Specifications S-48 and S-49
Case No. 868
Revision of Tables P-9 and U-3
Case No. 869
Revision of Par. P-17
Cases Nos. 871 and 872
Revision of Par. P-112
Case No. 873
Revision of Table P-16
Case No. 875
Revision of Table A-9

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The New Callendar Steam Tables

THE 1939 CALLENDAR STEAM TABLES. Edited and compiled by G. S. Callendar and A. C. Egerton. Published for the British Electrical and Allied Industries Research Association, Edward Arnold & Co., London, England, 1939. Cloth, 66 pp., 8 × 10 7/8 in., 12s, 6d.

REVIEWED BY R. C. H. HECK[1]

EARLY in 1939 the new Callendar Steam Tables were published in London. Based on the same body of data and keeping within the tolerances of the skeleton tables fixed by the Third International Steam Tables Conference in 1934, this formulation must run closely with the Keenan and Keyes tables of 1936. Differences are too small for easy graphical exhibit, but can be shown effectively by numerical comparisons.

COMPARISON WITH KEENAN AND KEYES 1936 TABLES

The first tabulation covers the saturation curves, on a base of temperature t. Note the four equal intervals from 32 to 212 F, then points at each 50 deg on the Fahrenheit scale; also the fact that the Callendar table stops just short of the critical temperature. The seven double columns compare pressure p, liquid volume v_f, dry-steam volume v_g, heat of liquid h_f, dry-steam heat h_g, and the corresponding entropies s_f and s_g. In general, differences are too small to have any practical significance; in h_g they rise to the order of 1 in 1000.

In Tabulation 2, four isotherms of superheated steam are compared, now considering only v and h, and for the latter the difference (KK — C) is given. The range is to the pressure and temperature limits of the Callendar table. Again, differences are small in the region of more data and greater use, but run larger at high pressures.

A third tabulation tries out the

[1] Research Professor, Mechanical Engineering, Rutgers University, New Brunswick, N. J. Mem. A.S.M.E.

TABULATION 2 FOUR ISOTHERMS

t	p	v KK	v C	h KK	h C	
400	1	512.0	511.5	1241.7	1242.3	+0.6
	50	10.065	10.05	1235.1	1234.9	—0.2
	100	4.937	4.938	1227.6	1227.3	—0.3
	150	3.223	3.228	1219.4	1219.3	—0.1
	200	2.361	2.368	1210.3	1211.0	+0.7
	247.3	1.8633	1.863	1201.0	1202.2	+1.2
600	1	631.2	630.5	1335.7	1336.5	+0.8
	200	3.060	3.055	1322.1	1321.6	—0.5
	400	1.4770	1.475	1306.9	1306.1	—0.8
	600	0.9463	0.944	1289.9	1288.7	—1.2
	800	0.6779	0.675	1270.7	1268.7	—2.0
	1000	0.5140	0.515	1248.8	1247.6	—1.2
	1200	0.4016	0.401	1223.5	1222.2	—1.3
	1400	0.3174	0.316	1193.0	1191.0	—2.0
	1542.9	0.2668	....	1165.5	.....	....
	1543.3	.....	0.268	.....	1166.2	....
800	1	750.4	749.4	1432.8	1433.4	+0.6
	400	1.8161	1.815	1416.4	1416.0	—0.4
	800	0.8763	0.873	1398.6	1398.5	—0.1
	1200	0.5617	0.562	1379.3	1378.0	—1.3
	1600	0.4034	0.404	1358.4	1357.1	—1.3
	2000	0.3074	0.308	1335.5	1333.4	—2.1
	2400	0.2425	0.244	1310.3	1307.4	—2.9
	2800	0.1953	0.196	1228.0	1278.6	—3.4
	3200	0.1589	0.160	1251.1	1247.3	—3.8
1000	70	12.383	12.36	1531.6	1530.7	—0.9
	400	2.134	2.131	1522.4	1521.7	—0.7
	800	1.0470	1.045	1511.0	1510.6	—0.4
	1200	0.6843	0.685	1499.2	1497.8	—1.4
	1600	0.5027	0.501	1487.0	1485.4	—1.6
	2000	0.3935	0.394	1474.5	1472.3	—2.2
	2400	0.3207	0.320	1461.7	1458.5	—3.2
	2800	0.2685	0.269	1448.5	1443.6	—4.9
	3200	0.2293	0.227	1434.9	1427.8	—7.1

TABULATION 1 THE SATURATION CURVES

t	p KK	p C	v_f KK	v_f C	v_g KK	v_g C	h_f KK	h_f C	h_g KK	h_g C	s_f KK	s_f C	s_g KK	s_g C
32	0.08854	0.0886	0.01602	0.01602	3306	3305	0	0	1075.8	1075.4	0	0	2.1877	2.1868
77	0.4593	0.459	1607	1608	694.9	696	45.02	45.05	1095.4	1095.1	0.0876	0.0876	2.0445	2.0439
122	1.7888	1.789	1621	1621	192.95	193.1	89.92	89.97	1114.5	1114.6	0.1679	0.1679	1.9293	1.9293
167	5.590	5.590	1643	1643	62.23	66.38	134.89	134.98	1133.0	1133.3	0.2425	0.2425	1.8350	1.8355
212	14.696	14.70	1672	1671	26.80	26.80	180.07	180.17	1150.4	1150.7	0.3120	0.3122	1.7566	1.7572
250	29.825	29.82	0.01700	0.01700	13.821	13.82	218.48	218.61	1164.0	1164.6	0.3675	0.3677	1.6998	1.7007
300	67.013	67.01	1745	175	6.466	6.466	269.59	269.7	1179.7	1180.2	0.4369	0.4371	1.6350	1.6359
350	134.63	134.6	1799	180	3.342	3.344	321.63	321.7	1192.3	1193.3	0.5029	0.5031	1.5783	1.5796
400	247.31	247.3	1864	186	1.8663	1.863	374.97	375.2	1201.0	1202.2	0.5664	0.5666	1.5272	1.5285
450	422.6	422.6	194	194	1.0993	1.099	430.1	430.3	1204.6	1205.6	0.6280	0.6282	1.4793	1.4806
500	680.8	680.8	204	204	0.6749	0.675	487.8	488.0	1201.7	1202.5	0.6887	0.6889	1.4325	1.4337
550	1045.2	1045.2	0.0218	0.0218	0.4240	0.424	549.3	549.4	1190.0	1190.9	0.7497	0.7499	1.3843	1.3854
600	1542.9	1543.3	236	236	0.2668	0.268	617.0	617.2	1165.5	1166.2	0.8131	0.8133	1.3307	1.3315
650	2208.2	2209	268	268	0.1616	0.1616	695.7	695.9	1118.5	1119.5	0.8828	0.8830	1.2637	1.2646
700	3093.7	3094	369	369	0.0761	0.0761	823.3	823.0	995.4	990.1	0.9905	0.9903	1.1389	1.1341
705	3197.7	3199	438	438	0.0589	0.0589	869.2	869.0	938.4	932.9	1.0293	1.0280	1.0886	1.0828
705.4	3206.2	....	503	....	0.0503	....	902.7	....	902.7	....	1.0580	....	1.0580	....

smoothness of a pair of isotherms, by showing successive differences of product pv and enthalpy h at 50-lb intervals along the 600-deg isotherm. In this respect the *KK* formulation is seen to be a more finished product than is the *C* formulation.

TABULATION 3 SMOOTHNESS OF AN ISOTHERM

(Temperature t = 600 F)

	pv				h			
p	*KK*		*C*		*KK*		*C*	
0	631.2		630.6		1335.8		1336.6	
		−4.6		−4.6		−3.3		−4.1
50	626.6		626.0		1332.5		1332.5	
		−4.8		−4.3		−3.4		−3.4
100	621.8		621.7		1329.1		1329.1	
		−4.8		−4.9		−3.4		−4.1
150	617.0		616.8		1325.7		1325.0	
		−5.0		−5.8		−3.6		−3.4
200	612.0		611.0		1322.1		1321.6	

As to the accuracy of such a showing of distributed physical quantity as the steam table, there are two main questions: How absolutely correct are the values given at any "point?" and, How smooth is the spacing of successive values, or how high is their relative correctness? The large body of steam research from 1905 to 1935 has so closely covered the saturation limits and large sections of the region of superheat that direct empirical plots will determine curves of very fair smoothness and consistency. However, it is highly desirable that systems of curves be represented and determined by equations, for three reasons:

1 Volume and heat formulas, usually of the general form $pv = RT - f(T,p)$ and $h = h_0 - f'(T,p)$, can be tied together by reasoned relations that must be satisfied in any formulation that is correct; and through such relationship bodies of data in the two fields of experiment support each other.

2 The use of equations yields smoother number series than can be set up by graphical numerical methods.

3 The establishment of equations that tend toward gas behavior permits and justifies extrapolation to high temperature.

The elder Callendar was the first thermal specialist to set up a pair of consistent equations, back in the year 1900 when data were few and rough; these were based on certain assumptions as to modified gaseous behavior. Good-enough in 1915 and the writer in 1920 proposed pairs of comparatively simple equations that represented fairly well the data then available. The Keyes equations, fitted primarily to the M.I.T. volume data, are exceedingly intricate and cumbersome for calculation—as are also equations set up in Germany and in Czechoslovakia within the last few years.

The *KK* table is computed from Keyes's equations up to a limit that starts at about half critical pressure on the saturation curve and rises in pressure as it runs out in temperature. Above that limit the isotherms are adjusted inward from the formulas, but with satisfaction of thermodynamic relations.

The whole new Callendar table is not said to be based on equations, nor does it show internal evidence of such construction. Presumably the thermodynamic interrelations have been used, although if experiments are correct in the two fields of volume and heat measurement, those relations will automatically be satisfied to some degree of accuracy. The only significant difference between the two formulations under consideration is an inward swing of the Callendar isotherms of that high pressure, seen in tabulation 2.

As to general arrangement, there is but one Callendar saturation table, the one based on temperature. But for better interpolation in the high range, intervals of two degrees are continued up to 700, whereas the *KK* table goes to five-degree intervals above 400. As already indicated, the superheat table runs to 3200 lb in pressure and to 1000 F in temperature.

In summary, for most practical purposes the two tabulations are hardly distinguishable, but for investigations that may depend on smooth variation of properties or coordinates the American tables are to be preferred.

Vapor Charts

VAPOR CHARTS. By Frank O. Ellenwood and Charles O. Mackey. John Wiley & Sons, Inc., New York, 1939. Cloth, 43 pp., 8 × 11 in., charts, tables, $2.50.

REVIEWED BY R. C. H. HECK[1]

THESE charts replace the Ellenwood Steam Charts of 1914. They are plotted from the Keenan and Keyes tables and are a beautiful piece of draftsman's work, clear and accurate. Broken into 21 sections for steam they are in effect as large as the 38 × 33-in. Mollier or h-s chart that comes with the Callendar tables. However, against the awkwardness of a large sheet, the broken chart calls for acquired ease in quickly passing from section to section.

A GRAPHICAL STEAM TABLE

The chart is, of course, a graphical steam table, showing the five coordinates p, v, t, h, and s. On the basis of his own investigation, once made by drawing a number of small outline charts, the writer believes that the choice of h and v as basic coordinates is probably the best that can be made for a general chart, provided that breaking into sections permits change in the scale of v. An important feature of the chart is that it covers the wet-steam region with the same degree of closeness as the superheat region; this obviates the long-range interpolation, in terms of quality x, that goes with use of the saturation tables.

Throughout, the chart is ruled at intervals of 1 Btu for h and at intervals of 0.01 of the maximum v in a section, that is, the division is 0.01 up to v = 1.0, 0.1 up to v = 10, 1 up to v = 100, 10 up to v = 1000, then 100 past v = 3000.

This scaling permits excellent accuracy in reading of these two dimensions, but other interpolations cannot be so close. The lines of constant entropy are spaced 0.01 of s apart, with from 10 to 20 Btu of h vertically between them (or less below the saturation curve). For finding h drop down the adiabatic, on an interpolated s, the reading on this chart will be less accurate than on the h-s chart.

In general, this graphical steam table will parallel the three-figure accuracy of the ten-inch slide rule, while the Keenan and Keyes table yields four-figure values, understanding that this means five figures when the first digit is 1 or 2.

An interesting and valuable supplement is the chart of water properties, which is very much more effective than the wide-spaced numerical table. There is also a three-section h on log p chart for ammonia, a two-section chart for freon, and a new psychrometric chart of Carrier type.

Pedagogically, the writer would prefer to start a student on the numerical steam tables, then later, perhaps, go to the use of the chart for large amounts of calculation based upon data of ordinary experimental precision.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Usefulness of Engineering Stressed at A.S.M.E. Annual Meeting in Philadelphia, Dec. 4–8

DEDICATED to the peaceful purpose of "broadening the usefulness of the mechanical-engineering profession," the Sixtieth Annual Meeting of The American Society of Mechanical Engineers, to be held in Philadelphia at the Bellevue-Stratford Hotel, Dec. 4-8, 1939, is the first annual meeting of the Society to be conducted outside of New York City since 1890, and the first national meeting in Philadelphia since 1887. A General Committee, composed of Philadelphians and headed by Nevin E. Funk, vice-president of the Philadelphia Electric Company, is now completing final plans for the meeting, including technical sessions, social functions, business meeting, inspection trips, college reunions, and a photographic exhibit.

Technical Sessions

Every mechanical engineer, no matter what his specialized field, will find something of professional interest in one or more of the 97 papers to be presented at 33 technical sessions which are scheduled during the week of the meeting. The chairman of the Technical Events Committee, J. J. McCarthy, wishes to call to the attention of those who cannot get away from their business during the daytime that five simultaneous technical sessions, covering the topics of work standardization, motion economy in machine-shop practice, aeronautics, elasticity, and domestic fuels, are planned for Monday evening, Dec. 4.

Other subjects to be discussed, as shown in the program which follows, are fuels, photoelasticity, scientific analysis of managerial problems, machine design, iron and steel, power, dynamics, industrial marketing, education and training, rubber and plastics, textiles, heat transfer, lubrication, railroads, materials handling, and thermodynamics. Numbered among the authors are such well-known engineers as J. N. Goodier, M. Hetényi, Kenneth Condit, C. W. Hazelett, W. M. White, A. R. Mumford, E. B. Ricketts, F. B. Heitkamp, Victor W. Page, Elmer H. Neff, F. Yerzley, L. M. Tichvinsky, P. H. Hardie, S. J. Needs, Arthur S. Fleming, D. B. Rossheim, C. T. Edgerton, E. G. Bailey, G. A. Hawkins, H. L. Solberg, A. A. Potter, J. C. Falkner, A. E. Grunert, Philip Sporn, and Louis Elliott.

Inspection Trips

A. G. Kisner, chairman of the Plant Trips Committee, reports that, besides the all-day inspection trip for hydraulic and other engineers to Conowingo, Holtwood, and Safe Harbor on Thursday, Dec. 7, morning or afternoon trips have been scheduled to the following plants in Philadelphia and vicinity: Tuesday afternoon, E. G. Budd Co., Link Belt Co., Curtis Publishing Co., Beck Printing Co., and General Electric; Wednesday morning, Baldwin-Southwark Locomotive Plant, and Schuylkill Generating Station; Wednesday afternoon, Westinghouse Elec. & Mfg. Co., SKF Industries, and Philadelphia Gear Works; and Thursday morning, Pennsylvania Forge Co., an oil refinery, Brown Instrument Co., and Leeds & Northrup Co. Complete details of the trips will be published in next month's MECHANICAL ENGINEERING.

Other Events of the Meeting

Other events scheduled for the Annual Meeting in Philadelphia include the business meeting on Monday afternoon, Dec. 4; Tuesday, S.P.E.E. luncheon and an evening get-together smoker at which the newly elected officers of the Society (see page 848) will be introduced; Wednesday, the annual student members' luncheon and the Annual Dinner with H. P. Liversidge, President of the Philadelphia Electric Company, as toastmaster, and the occasion for the conferring of honors and awards (see page 844), a popular scientific demonstration by Lawrence Hawkins, manager of the General Electric Laboratory, and the presidential address by Prof. A. G. Christie on "Training the Young Mechanical Engineer;" and Thursday, luncheon for all meeting participants and college reunions.

Complete details of the program for the women, including shopping trips, visits to historic spots, and informal social functions, being prepared by the Philadelphia Women's Committee will be found in the next issue of MECHANICAL ENGINEERING.

THE BENJAMIN FRANKLIN MEMORIAL AND THE FRANKLIN INSTITUTE, PHILADELPHIA

Program for A.S.M.E. Sixtieth Annual Meeting

Philadelphia, Pa., December 4–8, 1939

MONDAY, DECEMBER 4

9:30 a.m.

Council Meeting
Sections Delegates' Meeting
Professional Divisions Delegates' Meeting

12:30 p.m.

Council, Sections Delegates' and Professional Divisions Delegates' Luncheon

2:00 p.m.

Business Meeting

4:30 p.m.

Public Hearing on Power Test Code for Dust-Separating Apparatus

6:00 p.m.

Research Committee Dinner
Work Standardization Dinner—Management Division

8:00 p.m.

Work Standardization

Fatigue as a Result of High Environmental Temperature, Physical Exercise, and High Altitude, by Ross A. McFarland
Some New Technique in Time and Motion Measurement, by David B. Porter

Machine Shop Practice

A New Method of Machine-Tool Spindle Analysis, by Thomas Barish[1]
Machine Design and Motion Economy—Building Motion Economy Into Machine Tools, by O. W. Habel and G. G. Kearful[2]

Aeronautics

Mechanical Engineering in Air-Mail Pickup Operation, by James G. Ray
Heating and Ventilating of the Modern Airplane, by Herbert Kunen
Mechanical Aspects of the North Beach Airport, by S. E. Stott
Progress Report on Aeronautics

Elasticity

The Solution of Closed Rings With Equally Spaced Supports, by M. B. Hogan[2]
The Distribution of Load on the Threads of Screws, by J. N. Goodier[2]
Solution of Rectangular Clamped Plate With Lateral Load by Generalized Energy Method, by Gerald Pickett[2]
Stresses and Deflections of Three-Dimensional Pipe Bends, by H. Poritsky and H. D. Snively[2]

Symposium on Domestic Fuels

Domestic Heating Boilers for Automatic Firing, by L. N. Hunter

[1] Published in this issue.
[2] To be preprinted for meeting and published later.

MONDAY (*continued*)

Anthracite as a Fuel for Domestic Heating, by Allen J. Johnson
Domestic Bituminous Stokers, by H. E. Winkler
Domestic Oil Burners, by M. A. Powers
Domestic Heating With Coke, by Charles C. Russell
Gas Heating, by C. G. Segeler

TUESDAY, DECEMBER 5

9:00 a.m.

Fuels

Which Fuel to Choose? by G. A. Anbro[1]
Modern Methods of Fuel Purchasing, by R. G. Rincliffe

9:30 a.m.

Photoelasticity

Stress-Concentration Factors Around a Central Circular Hole in a Plate Loaded Through a Pin in the Hole, by M. M. Frocht and H. N. Hill[2]
Some Applications of Photoelasticity in Turbine-Generator Design, by M. Hetényi[2]
A Photoelastic Study of Stresses in Rotating Disks, by R. E. Newton[2]
A Theoretical Investigation of Plastic Torsion in an I-Beam, by D. G. Christopherson (by title)
A Two-Load Method of Determining the Average True Stress-Strain Curve in Tension, by C. W. MacGregor[2] (by title)

Scientific Analysis of Managerial Problems

The Engineering Method in Management, by Andrew I. Peterson[2]
Statistics Applied to Mass Production, by W. A. Shewhart
Statistics in the Formulation of Industrial Policy, by K. H. Condit

Machine Design

The Principles of Instrument Design, by C. S. Draper and George Bentley
Quick-Acting Release Latches, by Carl Thumim[1]

Iron and Steel

Direct Rolling of Metal, by C. W. Hazelett[1]
Some Designs and Uses of Forged, Heat-Treated, and Hardened-Steel Rolls in the Steel Industry, by J. R. Adams and H. L. Watson

Prime Mover Regulation (I)

Hydraulic Turbine Governing, by W. M. White
Power Swings in Hydroelectric Power Plants, by W. J. Rheingans[2]
Generator Characteristics as Affecting System Operation, by Sherwin H. Wright[2]

TUESDAY (*continued*)

12:30 p.m.

S.P.E.E. Luncheon
Machine Design Luncheon

2:30 p.m.

Dynamics

Mathematical-Machine Determination of the Vibration of an Accelerated Unbalanced Rotor, by J. G. Baker[2]
The Normal Modes of Vibration of Beams Having Noncollinear Elastic and Mass Axes, by Clyne F. Garland[2]
Measurement of Impact Strains by a Carbon-Strip Extensometer, by R. Fanning and W. V. Bassett[2]
A Convenient Electrical Micrometer and Its Use in Mechanical Measurements, by Ross Gunn[2]

Fuels

Characteristics of Cloth Filters on Coal-Dust Air Mixtures, by A. R. Mumford, A. A. Markson, and T. Ravese
Defining Equitable Limits of Dust Emission From Stacks, by P. H. Hardie[2]

Power

Panel Discussion on Two Years' Experience With High-Pressure, High-Temperature Superposed Power Installation, led by E. B. Ricketts
Two Years of Experience With High-Pressure, High-Temperature Equipment at Waterside Station, by J. C. Falkner[2]
Fisk Station Topping Unit Operation, October, 1937, to August, 1939, by A. E. Grunert[2]
Logan Operating Experience, by Philip Sporn[2]
High-Pressure, High-Temperature Superposed Power Installation at Omaha Station of Nebraska Power Co., by Louis Elliott[2]

Industrial Marketing

Introductory Remarks—The Marketing Movement in Mechanical Engineering, by John R. Bangs, Jr.
Gearing Engineering to Sales, by F. B. Heitkamp
The Use of Market Research in Introducing New Industrial Products, by Robert Gibson

6:00 p.m.

Smoker

WEDNESDAY, DECEMBER 6

9:30 a.m.

Education and Training

Education and Training of Apprentices for the Aeronautical Industry, by Victor W. Page

WEDNESDAY (*continued*)

Apprentice Training, by Ray E. Ellis
Apprenticeship in the Machine-Tool Industry, by Elmer H. Neff

Prime Mover Regulation (II)

Steam-Turbine Governors, by Reed J. Caughey[2]
Constant System Speed and the Steam-Turbine Governor, by A. F. Schwendner[2]

Lubrication (I)

The Influence of Crystal Size on the Wear Properties of High-Lead Bearing Metal, by John R. Connelly[2]
Temperature Distribution in Bearings, by E. S. Pearce[2]

Textile (I)

Engineering Aspects of Cutting-Up Trade, by A. C. Abrahams
Finishing of Spun-Rayon Fabrics, by Harold DeW. Smith
Weaving of Spun-Rayon Fabrics, by Albert Palmer
Spinning of Spun-Rayon Yarn, by Carl D. Brandt

Heat Transfer

Laminar-Flow Heat Transfer, by R. H. Norris and D. D. Streid
Heat Transfer to Falling-Water Films, by W. H. McAdams, T. B. Drew, and G. S. Bays, Jr.[2]
The Calculation of Heat Transfer in Cross-Flow Exchangers, by E. A. Schumann
Mean Temperature Difference in Design, by W. M. Nagle, A. C. Mueller, and R. A. Bowman
Forum Discussion on Testing of Heat-Transfer Equipment, led by H. C. Hottel

Student and Junior Session

12:30 p.m.

Student Luncheon
Textile Luncheon

Registration Fee for Non-Members at the 1939 Annual Meeting

There will be a registration fee of $2 for nonmembers attending the 1939 A.S.M.E. Annual Meeting. For nonmembers wishing to attend just one session the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring nonmember guests may avoid this fee by writing to the Secretary of the Society before December 1 asking for a guest-attendance card for the Annual Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member*.

WEDNESDAY (*continued*)

2:30 p.m.

Rubber and Plastics

Permanence of the Physical Properties of Plastics, by J. Delmonte[2]
Neoprene as a Spring Material, by F. L. Yerzley[2]
The Importance of the Service Temperature Flow Characteristics of Thermoplastics, by W. F. Bartoe[2]

System Regulation

The Field of System Governing, by Albion Davis
Regulation of System Load and Frequency, by Herbert Estrada and Henry A. Dryar[2]
Operating Experiences in System Speed Regulation, by O. Holden

Textile (II)

Testing the Stiffness of Yarns and Twines, by D. C. Scott
Factors Influencing the Design, Selection, Operation, and Maintenance of Machinery Used in the Application of Fast Dyes to Cellulosic Fabrics, by O. W. Clark

Lubrication (II)

Boundary Film Investigations, by S. J. Needs[2]
Properties and Performance of Plastic Bearing Materials, by L. M. Tichvinsky[2]

Administrative Organization

Administrative Organization in Government, by Arthur S. Fleming
Administrative Organization in Business and Industry, by Lawrence A. Appley

6:30 p.m. Banquet and Honors

THURSDAY, DECEMBER 7

9:30 a.m.

Piping

The Significance of, and Suggested Limits for, the Stress in Pipe Lines Due to the Combined Effects of Pressure and Expansion, by D. B. Rossheim and A. R. C. Markl

Industrial Instruments and Regulators

Thermostatic Bimetals, by S. G. Eskin and J. R. Fritze[2]
Automatic Control in the Presence of Process Lags, by C. E. Mason and G. A. Philbrick[2]

Railroad

Railway-Car Engineering, by D. S. Ellis[2]
Whip Stress in a Locomotive Main-Rod at 100 Mph, by M. W. Davidson[2] (by title)
Progress in Railway Mechanical Engineering, 1938-1939[2]

Mechanical Springs

Calculation of the Elastic Curve of a Helical Compression Spring, by H. C. Kevsor[2]
Helix Warping in Helical Compression Springs, by D. H. Pletta and F. J. Maher[2]
Progress Report—Fatigue Tests of Helical Compression Springs at Wright Field, by C. T. Edgerton

Official Notice

A.S.M.E. Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held Monday afternoon, December 4, at 2:00 p.m. in the Rose Room (and *not* Room 115 as was announced in the October issue) of the Bellevue-Stratford Hotel, Philadelphia, Pa., as a part of the Annual Meeting of the Society.

The Annual Report of the Council and other Committee reports will be presented for the action of the members. There will be an opportunity also for members desiring to do so to bring any other business before this meeting.

(*Signed*) C. E. DAVIES
Secretary

THURSDAY (*continued*)

Progress Report on Book on Strength of Metals, by D. J. McAdam, Jr.

Thermodynamics

A Rational Representation of the Flow Performance of Reaction Steam-Turbine Blading, by Adolf Egli[2]
The Viscosity of Superheated Steam, by G. A. Hawkins, H. L. Solberg, and A. A. Potter[2]
Report on Change of Enthalpy of Steam With Pressure at Low Temperatures, by F. G. Keyes

12:30 p.m. General Convention Luncheon; Industrial Instruments Luncheon

2:30 p.m.

Turbine Blading

An Investigation of the Energy Losses in Steam-Turbine Elements by Impact Traverse Static Tests With Air at Subacoustic Velocities, by W. R. New
Photoelastic Analysis of Stresses in a Steam-Turbine Blade Root, by J. J. Ryan and J. T. Rettaliata[2]
The Automatic Integrating Pressure-Traverse Recorder for Study of Flow Phenomena in Steam-Turbine Nozzles and Buckets, by H. Kraft and T. M. Berry[2]

Materials Handling

Continuous Transportation Methods of Dirt Disposal on Large Construction Operations, by S. M. Mercier
Canadian Mine Hoists, by H. V. Haight and G. M. Dick
Theory and Operation of Continuous Weighing, by James A. Flint

Steam Generators

Steam Boiler Performance and a Method of Comparison, by E. G. Bailey
The Locomotive Boiler, by C. A. Brandt[2]

6:00 p.m. College Reunions; Power Test Codes Committee Dinner

DELAWARE RIVER BRIDGE, NEW CUSTOM HOUSE AT RIGHT

A.S.M.E. Awards for 1939 Voted by Board and Council

Will Be Presented at Annual Meeting in Philadelphia

RECOMMENDED by the Board of Honors and Awards at its meeting of Sept. 26, 1939, and subsequently approved by the Council of The American Society of Mechanical Engineers, the following A.S.M.E. medals and awards will be conferred at the sixtieth Annual Meeting of the Society to be held in Philadelphia, Dec. 4–8, 1939:

Holley Medal to Dr. C. E. Johansson, Eskilstuna, Sweden, for perfecting and producing in commercial quantities his gage blocks which are used throughout the world by machine and engine manufacturers.

A.S.M.E. Medal to James E. Gleason, president, Gleason Works, Rochester, N. Y., for his development of the hypoid gear which is used in today's automobiles.

Worcester Reed Warner Medal to Dr. Rupen Eksergian, Edw. G. Budd Manufacturing Co., Philadelphia, Pa., for his contributions to permanent engineering literature.

Melville Medal to Lester M. Goldsmith, Atlantic Refining Co., Philadelphia, Pa., for his paper, "High-Pressure High-Temperature Turbine-Electric Steamship *J. W. Van Dyke*," which was presented at the 1938 Annual Meeting and published in Transactions of the A.S.M.E., April, 1939.

Pi Tau Sigma Medal to John I. Yellott, Stevens Institute of Technology, Hoboken, N. J., for "outstanding achievements in mechanical engineering."

Charles T. Main Award of $150 to James R. Bright, graduate of Lehigh University, General Electric Co., Schenectady, N. Y., for his paper, "The Economics of Investment in New Manufacturing Equipment—With Concrete Cases."

Undergraduate Student Award of $25 to David T. James, graduate of Michigan State College, E. I. duPont de Nemours Co., Niagara Falls, N. Y., for his paper, "Bells—Concerning Their Tones."

Members of the Board of Honors and Awards for 1939 are Harte Cooke, chairman, W. H. Carrier, J. W. Roe, R. V. Wright, D. C. Jackson, and Cornelius Kirby, junior advisory member.

Nominations for the A.S.M.E. Medal, the Holley Medal, and the Warner Medal, were made to the Board by the Committee on Medals which consists of the five members of the Board of Honors and Awards and C. L. Bausch, F. M. Gunby, R. L. Sackett, E. R. Fish, H. C. Meyer, L. W. Wallace, H. A. Everett, H. A. S. Howarth, Geo. A. Orrok, Alexander Klemin, E. W. O'Brien, E. S. Pearce, C. M. Allen, R. L. Daugherty, and W. A. Hanley.

The task of reading the many student papers submitted and recommending to the Board the recipients for the Charles T. Main Award and the A.S.M.E. Undergraduate Student Award was performed by the Committee on Relations With Colleges, consisting of F. V. Larkin, chairman, H. O. Croft, E. W. O'Brien, A. C. Chick, J. D. Cunningham, and the advisory members, H. E. Degler, S. F. Duncan, E. O. Eastwood, F. H. Prouty, G. L. Sullivan, and junior advisory member, J. I. Yellott.

President Christie Heads Maryland License Board

AS REPORTED in last month's MECHANICAL ENGINEERING, a Maryland State Board for Registration of Professional Engineers and Land Surveyors was recently established. At the first meeting of the Board, members of which were appointed by the Governor of Maryland, A. G. Christie, President of the A.S.M.E., was chosen chairman; Dr. Sheppard T. Powell, member A.S.M.E., vice-chairman; and John R. Baker, member A.S.M.E., secretary. Other members of the License Board are F. O. Schnure and Vincent Cockey.

A.S.M.E. Participates in Thurston Celebration

OFFICIALLY represented by President A. G. Christie, Past-Presidents D. S. Kimball, W. F. Durand, and Harvey N. Davis, and Vice-President James W. Parker, the A.S.M.E. participated with Cornell University in the celebration of the 100th anniversary of the birth of Robert Henry Thurston, first president of the Society, which was held at Ithaca, N. Y., on Oct. 25, 1939. According to a preliminary program issued prior to the celebration, the speakers scheduled to talk at the morning convocation included Dr. Durand, Dr. James P. Adams, vice-president of Brown University, Admiral Wilson Brown, superintendent of the U. S. Naval Academy, Dr. Davis, and Dean S. C. Hollister, College of Engineering, Cornell University. Of particular interest to the many A.S.M.E. members who attended were the exhibits of Dr. Thurston's publications and of apparatus he designed.

Chemical Industries Exposition in New York, Dec. 4–9, 1939

THE seventeenth Exposition of Chemical Industries will be held at Grand Central Palace, New York City, Dec. 4–9. Of interest to mechanical engineers will be the story of modern metals told in terms of their applications in all fields of manufacturing industry with special emphasis on the uses of stainless steel, nickel, and chromium-clad steel, and the nonferrous metals and alloys. There will also be displays of modern plastics which will provide one of the best means for examining the total advance of this art and witnessing the complete range of its applications.

Last Chance to Enter Photographic Contest at Philadelphia

MEMBERS of the Society and their friends are invited to submit technical and nontechnical photographs for showing at the Fourth Annual A.S.M.E. Photographic Exhibit to be held during the 1939 Annual Meeting of the Society in Philadelphia, Dec. 4–8, 1939. Prints mounted on 16 × 20-in. light-colored cards should be sent, on or before Nov. 30, 1939, to the A.S.M.E. Photo Exhibit Committee, The Engineers Club, 1317 Spruce Street, Philadelphia, Pa., together with an entry fee of $1 to cover return postage, insurance, wrapping, etc. This year, MECHANICAL ENGINEERING will award cash prizes of $5, $3, and $2, and honorable-mention citations for all photographs selected for reproduction on the cover and in the editorial pages of the Society's journal. Official entry forms may be secured from the Committee.

A.S.M.E. to Participate in Temperature Symposium in New York, Nov. 2–4

Engineering Sessions on Thursday Evening and Saturday Morning

TEMPERATURE will be the subject of the symposium to be held Nov. 2–4, at the Hotel Pennsylvania, New York City, under the auspices of the American Institute of Physics with the cooperation of The American Society of Mechanical Engineers, National Bureau of Standards, National Research Council, and many other scientific and technical societies. More than 100 papers will discuss the measurement and control of temperature in medicine, science, and industry. Representing the A.S.M.E. on the Symposium Committee is H. F. Mullikin, analytical engineer, Babcock & Wilcox Co., who heads the Committee on General Engineering which has secured many worth-while papers for the engineering sessions to be held on Thursday evening, Nov. 2, and Saturday morning, Nov. 4.

The Thursday morning session will feature papers on thermometric metals and a special topic. In the afternoon, the speakers at the general session will be Dr. E. F. DuBois, "Temperature of Man in Health and Disease;" Dr. W. T. Wensel, "Temperature and Temperature Scales;" Dr. L. O. Sordahl, "Pyrometry of Liquid Steel in the Open-Hearth Furnace;" and Dr. Sanford A. Moss, "The Standardization of Symbols."

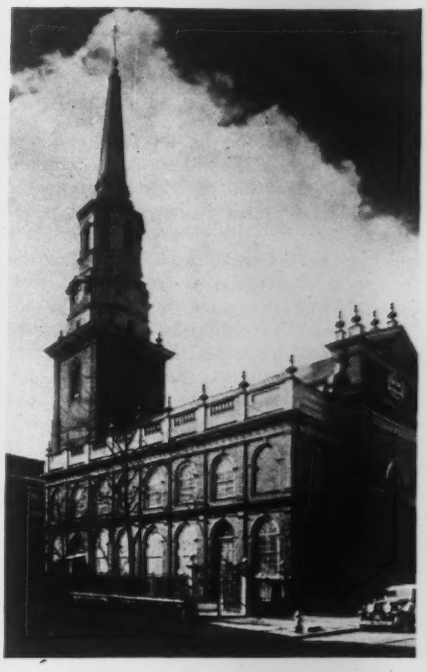
Engineering Sessions

Of particular interest to engineers will be the simultaneous sessions on Thursday evening, Nov. 2, which will cover general engineering, nonferrous metals and ceramics, and optical pyrometry. The first session includes papers mainly on temperatures in the power field; the second will have papers covering brass, bronze, tin, pyrometric cones, and ceramic temperature scales; and the last session will feature descriptions of different types of pyrometers.

Saturday morning, Nov. 4, the session on general engineering will include papers on air conditioning, food industry, meat industry, and surface measurements. Other sessions likely to be of interest to engineers are the following: Friday morning, oil production, thermodynamics, and gas scales; Friday afternoon, ferrous metals, petroleum refining, and special theories and methods; and Saturday afternoon, automatic control and industrial instruments.

Complete Program Available

A very complete program, containing titles, names of authors, and full abstracts of all papers to be presented, may be obtained at the meeting headquarters in the Hotel Pennsylvania or from the American Institute of Physics, 175 Fifth Avenue, New York City, upon payment of the registration fee of one dollar. All A.S.M.E. members and their friends are cordially invited to attend the symposium.



OLD CHRIST CHURCH IN PHILADELPHIA

(A masterpiece of early Colonial architecture preserving in their original form the pews of such patriots as General Washington and Benjamin Franklin.)

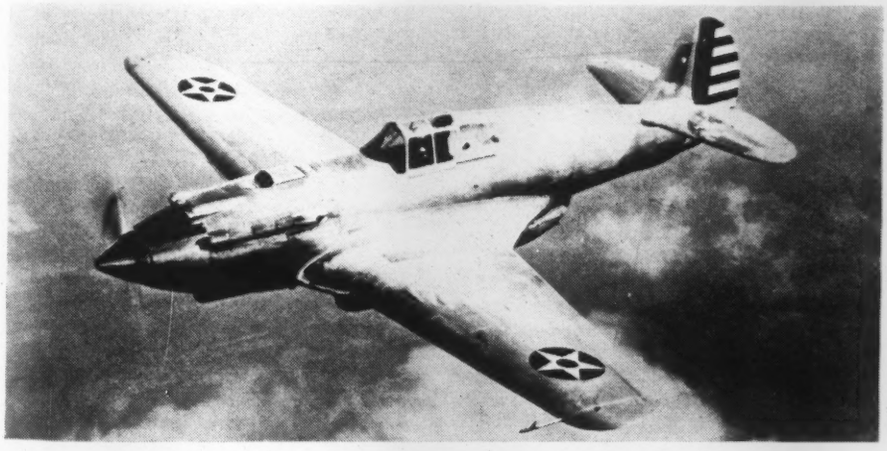
1938 Report on Oil Engine Power Cost Now Available

THE Oil Engine Power Cost Report for 1938 is now available. This report, prepared annually by a subcommittee of the A.S.M.E. Oil & Gas Power Division, will be of interest to anyone concerned with the operating costs of Diesel-engine generating plants. The purpose of the report is to record and present actual operating results of Diesel-engine generating plants in the United States. Plants are classified as building power plants, industrial power plants, municipal power plants, private power-company plants, and municipal pumping plants. In addition to this classification, the plants are keyed so as to indicate whether they are base-load, complete-power, peak-load, or stand-by plants. Thus a reader of the report is able to identify and study the type of plant in which he is particularly interested.

As in past reports, no data on investment costs or fixed charges are included. Production costs are given in detail and cover data from 151 oil-engine generating plants containing 444 engines, totaling 248,548 rated horsepower. The total net output for the plants tabulated in the 1938 report amounted to 318,636,891 kilowatthours.

Information on production cost for each of the 151 plants is presented in Table I and includes capacity load and net output data in addition to the unit costs making up total production cost. Table II shows the comparative production costs for each of two or more years for 132 plants. Each succeeding year has added to the value of this table and in the current report the number of plants reported for 5 successive years or over has reached 85. Data on engine details and operating information are given in Table III, which includes, in addition to engine data, information on lubrication, fuel, engine loading, cooling systems, waste-heat utilization, maintenance and repairs, enforced shutdowns, and attendance labor. In order that the data on fuel and lubricating-oil economies may be easily assimilated these data have been plotted in chart form with median and boundary lines included to assist the eye in subdividing the plotted data.

Copies of the report may be obtained from Society headquarters at a cost of $1 per copy. The price to A.S.M.E. members is 80 cents and lower prices are available for quantity lots.



CURTISS P-40 PURSUIT PLANE

(The new Curtiss P-40 pursuit ship, said by observers to be capable of 400 to 450 mph, will be discussed during the Aeronautic Division session of the A.S.M.E. Annual Meeting, Philadelphia, Pa., on the evening of Dec. 4, 1939, at the Bellevue-Stratford Hotel.)

Proposed Revisions of Two A.S.M.E. Power Test Codes Available for Comment

COMPLETION of the proposed revisions of the 1931 edition of the Code on Definitions and Values and the 1928 edition of the Test Code for Steam Turbines has been announced by the Committee on Power Test Codes of The American Society of Mechanical Engineers. The revisions are now available in proof form for criticism and comment.

In making the announcement it was pointed out that in 1918 the A.S.M.E. Committee on Power Test Codes was organized by the Council to revise and enlarge the group of ten power test codes of the Society published in 1915. This committee consists of a main committee of 25 members under the chairmanship of Francis Hodgkinson and 21 individual technical committees, each one of which is composed of 7 to 22 specialists. These individual committees have drafted test codes for the various prime movers and other auxiliary and related apparatus which constitute power-plant equipment.

Code on Definitions and Values Revised

The committee which has been at work on the revision of the Code on Definitions and Values consists of Messrs. R. J. S. Pigott, chairman, L. J. Briggs, W. F. Davidson, A. L. Kimball, L. S. Marks, F. G. Philo, J. C. Smallwood, P. W. Swain, and A. C. Wood. The committee believes that this publication in its present form meets the needs of all groups which from time to time have occasion to make acceptance tests of prime movers and auxiliary apparatus.

In the present proposed revision all of the items covered are included in three tables under the following headings, respectively: (1) Fundamental units and constants, (2) units of output, and (3) units of performance or 1/performance. The items in the tables are arranged alphabetically for convenience in use.

Some important reference paragraphs in which major changes have been made as a result of the revision and on which comment is solicited are quoted in the following paragraphs.

Heat Value. The terms calorific value, heating value, heat of combustion are in general use to designate the quantity of energy per unit quantity of fuel transmitted in a fuel calorimeter as a result of the complete reaction of the combustible in the fuel with oxygen and the cooling of the products of combustion to the initial temperature of the air-fuel mixture. These terms are qualified by the words gross, total, high or higher, and net, low or lower, to indicate that the energy of vaporization of the water of combustion is included in the heat transferred, or is excluded from it.

The terms adopted in this code are high heat value and low heat value, abbreviated hhv and lhv, and defined in the following:

The energy transmitted in a fuel calorimeter depends upon the method of burning the fuel (*a*) at constant pressure, as in a boiler furnace or as in a Junkers calorimeter, and (*b*) at constant volume, as (approximately) in an Otto-type internal-combustion engine or as in a bomb calorimeter. The difference between hhv or lhv at constant pressure and the corresponding quantity at constant volume depends upon change of volume before and after the reaction at constant pressure, the final temperature being the same as the initial. An increase of volume following combustion at constant pressure is accompanied by energy delivered as work to the atmosphere enveloping the reaction. Consequently, the energy transmitted in a constant-pressure calorimeter is less than in a constant-volume calorimeter, in which no work is done, if the volume of the products exceeds the volume of the mixture at constant pressure; and vice versa. If there is no change in volume, the heat at constant pressure equals the heat value at constant volume.

The energy transmitted in a fuel calorimeter also depends upon the initial temperature of the oxygen or air-fuel mixture, to which temperature the products are cooled after combustion in the calorimeter. The quantity referred to as heat value numerically equals the energy resulting from the combustion of the fuel, plus enthalpy of the products at the temperature of the mixture just before combustion, minus the enthalpy of the mixture at the same temperature, for constant-pressure combustion. For constant-volume combustion, the difference between the internal energies of products and mixture applies, instead of the difference in enthalpy values. This enthalpy, or internal energy, difference varies as the common temperature of fuel mixture and products varies; hence the variation of heat value with temperature.

The high heat value at constant pressure of hydrogen is greater than its hhv at constant volume by about 1.25 per cent, but for most commercial fuels this variation, due to the method of burning, is less than 0.5 per cent. The variation of the heat value of hydrogen at constant pressure with initial temperature is about 1.25 per cent for a range of temperature from 40 F to 500 F, but for commercial fuels this variation is much less. Because of these small variations, the heat value of a fuel as determined by either a constant-pressure or a constant-volume calorimeter at ordinary atmospheric temperatures is acceptable for engineering calculations regardless of the actual conditions of burning the fuel in service.

The high heat value at constant pressure of a fuel may be defined as the energy transferred from the products of complete combustion per unit mass of a solid or liquid fuel, or per unit standard volume of a gas fuel, when the products are cooled to the initial temperature of the oxygen, or air-fuel mixture, and includes the enthalpy of vaporization of all of the water of combustion from the hydrogen in the fuel. The pressure and temperature may be taken at the prevailing atmospheric values.

The low heat value at constant pressure is defined the same as the high except that the enthalpy of vaporization of the water of combustion is excluded from the energy transferred on the assumption that the water vapor of combustion is not condensed.

For gas fuels, the unit standard volume is one cubic foot of gas at one standard atmosphere and standard temperature, the gas having a relative humidity of 100 per cent.

The term heat value, when unqualified by the words high or low, will be taken to mean the high heat value at constant pressure. The standardization of high heat value for computation of heat input, thermal efficiencies, etc., is adopted in order that all heat apparatus shall be charged on the same basis and is in conformity with American custom. The low heat value is to be used only for such calculations as for flame temperatures in which the use of the high heat value is incorrect.

High Heat Values. A table of heats of combustion for dry saturated gases is included in the revision of the code. This information is computed from values given in National Bureau of Standards Circular C417 (March 1, 1938) with the exception of H_2S and S.

Standards, Primary. Congress has never fully exercised its constitutional power of fixing the standard of weights and measures throughout the United States. The National Bureau of Standards is now the legal custodian of the standards; and in the absence of specific action to the contrary by Congress, its practice in determining values of lengths and masses is authoritative. The Federal Statute of July, 1866, on metric standards defines the meter in terms of the British inch and yard.

The primary standard of length is the international prototype meter, of which the Bureau has the two official copies assigned by lot to the United States. Determinations of length are referred to the primary standard through these copies by using the relation 1 meter = 39.37 in. Similarly, the primary standard of mass is the international prototype kilogram, of which two official copies are in the custody of the National Bureau of Standards; and determinations of mass are referred to the kilogram by using the relation 1 lb = 0.453-5924 kg. There is no legally established United States primary standard yard bar or pound mass, and the adoption of the numerical relations just mentioned is, in effect, a definition of the foot and pound. Although the conversion relation, 1 in. equals 2.54 cm, is slightly in error, the recent tendency has been to accept it as the definition. For the purpose of this code the error is immaterial. One inch = 2.54 cm is used as a basic ratio for all equivalent values in the code. This practice is in accord with that of Keenan and Keyes in their "Thermodynamic Properties of Steam."

Watt—One International. The relation one international watt = 1.0003 absolute watts has been adopted by Keenan and Keyes in their 1936 edition of the steam tables. It is, therefore, the basis of the values given in this code. However, the experimental values for the ratio have changed somewhat and appear to be converging toward 1.0002. The value is to be fixed by international agreement.

The graphical symbols representing electrical equipment have been omitted and those retained are now in accord with those approved by the A.S.A. The letter symbols included in the proposed revision are also in agreement with those adopted by the A.S.A.

Test Code for Steam Turbines

The Test Code for Steam Turbines is one of the original group of ten codes forming the 1915 edition of the A.S.M.E. Power Test Codes. A revision of that code was undertaken in 1924 and completed by the committee and approved by the Council as the standard practice of the Society in 1928.

The present revision of the code was undertaken in 1932 by the following committee expanded for that purpose: Messrs. C. Berry, chairman, I. E. Moultrop, secretary, O. D. H. Bentley, W. E. Caldwell, C. B. Campbell, A. G. Christie, Hans Dahlstrand,

V. M. Frost, A. E. Grunert, Francis Hodgkinson, S. A. Moss, R. O. Muller, T. E. Purcell, C. C. Thomas (deceased), and G. B. Warren.

The new code is divided into six sections as follows:

1 *Object and Scope* states the kinds of tests and the types of turbines embraced by the code.

2 *Description and Definitions of Terms* defines and describes all the pertinent terms employed in the code together with their units and symbols.

3 *Guiding Principles* gives general considerations concerning tests and the approach to a test, the agreements to be reached prior to a test, and the preliminaries.

4 *Instruments and Methods of Measurement* lists the necessary instruments, gives definite rules for the making of all measurements including output, steam quantities, leakages, pressures, temperatures, speed, and time. It includes measurements required for emergency governor operation.

5 *Computation of Results* provides complete formulas for the calculation of results including rules for the application of corrections for use when the operating conditions of a test deviate from those specified.

6 *Report of Tests* comprises complete tabulations for report for any of the types of turbines embraced by the code.

This code is to be supplemented by an appendix which will give numerical examples of computations based on hypothetical test values. It exemplifies the application of corrections, of allowances for limits of possible error of instruments or methods of measurement, and corrections to mercury barometers, manometers, gives examples of calculations for flow measurements, feedwater-heater computations, and complete test reports of a hypothetical reheating-regenerative turbine, an extraction-type turbine, and a mixed-pressure turbine. It also includes computations incidental to determining the emergency-governor performance. This appendix was completed and circulated to interested parties some time ago, but it is now subject to some revisions because of changes to the test code that have been agreed upon subsequently.

Because of the restricted scope of the 1928 edition of the A.S.M.E. Test Code for Steam Turbines and as a result of discussions at the various meetings of the International Electrotechnical Commission Advisory Committee on Steam Turbines over a period of six years, the A.S.M.E. Committee on Steam Turbines was enlarged in 1932 and charged with the duty of revising the code.

In the development of this revision of the steam-turbine code the committee has been governed by the more recent concepts of the purpose and scope of power test codes. This new code is, therefore, not primarily concerned with the giving of instructions as to how to carry out an acceptance test, but rather with the laying down of mandatory rules without ambiguity for the methods of making the various measurements, the methods of correction of the test data to the specified conditions, the methods of calculating the test results, and methods of operating the turbine during test. In short this code is intended to serve as a means of resolving disputes, should any arise, between the parties to a test.

The Parker Case

IN VIEW of certain printed material that has been received by our members, it seems necessary to review briefly the various Parker cases and remove some misunderstandings.

In December, 1933, the Council removed John Clinton Parker from membership in the Society for conduct unbecoming a Member. In August, 1933, Mr. Parker accused members and former members of the Council of misconduct which he was not able to substantiate in his appearance before the Council.

In September, 1934, Mr. Parker brought a proceeding in the Supreme Court of New York County charging misfeasance, malfeasance, and nonfeasance by Council members in respect to the Engineering Index, the Boiler Code, and other matters. He asked for an investigation or a "visitation" as provided in the Membership Corporation Law of New York State. In answer the Society pointed out that Mr. Parker was not a member of the Society. Mr. Justice McGoldrick ordered Mr. Parker restored to membership on the grounds that Mr. Parker's charges of August, 1933, against the Council made it impossible for the Council to sit in judgment on itself and punish Mr. Parker. The Court also directed that the "visitation" be carried out with Mr. Philip J. Sinnott acting as referee.

In November, 1935, Referee Sinnott made an exhaustive report to the Court in which he found as conclusions of law:

1 I find that none of the property or funds of The American Society of Mechanical Engineers has been misappropriated or diverted to any other purpose than that for which such Society was incorporated.

2 I find that said Society has not been engaged in any other business than that specified in its Certificate or Act of Incorporation.

3 I find that the said Society's acts and transactions reviewed before me were properly had and done within its lawful discretionary right and power, and that there is no ground for any judicial condemnation thereof, or interference therewith.

In June, 1936, Judge McGoldrick approved this report and directed Mr. Parker to pay the Society $1500 costs in the visitation proceeding. He has not paid these, as will be seen later.

The Society not wishing to incur legal expenses did not appeal from this favorable decision and thereby accepted the preliminary order restoring Mr. Parker to membership.

In December, 1936, Mr. Parker, now joined by a dozen associates, brought an action against present and former members of the Council, charging that the Engineering Index activity of the Society was outside the scope of the Society's Charter and asking these present and former directors to pay to the Society's treasury the monies spent on the Index in excess of income. Mr. Justice Black heard the case in the Supreme Court of New York County and in June, 1938, found that the Index was within the scope of the Charter but that the Council members had been negligent. Upon an authorization voted by the Society members at St. Louis in June, 1938, an appeal was taken from this extraordinary decision of Judge Black and in December, 1938, the Appellate Division of the Supreme Court of New York County unanimously reversed Judge Black's decision and exonerated the Society officers. Mr. Parker appealed to the Court of Appeals which on June 19, 1939, unanimously sustained the Appellate Division. In this action the defendants have judgments against Mr. Parker and his associates for $2829.01 in costs.

On September 25, Mr. Parker, acting as his own counsel, made a request to the Court of Appeals for the privilege of rearguing his case before the Court of Appeals. On October 10, the Court of Appeals refused to grant the reargument.

Since Mr. Parker has not paid any of the sums owing, your Executive Committee instituted proceedings in March in Philadelphia (the address given by Mr. Parker to the Society) to collect the $1500 judgment in the "visitation" proceeding. On September 7, 1939, the Court gave the Society a judgment against Mr. Parker for $1783.50, the original $1500 with interest. As we go to press Mr. Parker has not paid this judgment. From remarks in his latest circular it appears that the Society may have difficulty in collecting either of the judgments which the courts have awarded it against Mr. Parker.

A large amount of time and energy has been spent by the members of the Council, the officers, and the staff of the Society in this litigation brought on by Mr. Parker, and the necessary expenses and counsel fees incurred have already amounted to large sums of money. While the result of the litigations has been to vindicate in every respect the action of the Society by its Council and officers, nevertheless the opinion of the membership is rapidly growing that such litigation does the Society harm. The members of the Society are not in favor of having differences of opinion respecting the policies of the Society fought out in the courts, instead of by the orderly procedure of discussion and vote of the membership.

(Signed) A. G. CHRISTIE,
President

Boston Civil Engineers Announce Freeman Lectures

THE Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass., is sponsoring a series of 18 lectures on hydraulics to be given by Dr. Kenneth C. Reynolds, associate professor of hydraulics at M.I.T., and a former holder of the John R. Freeman Traveling Fellowship of the B.S.C.E., and by other nationally known engineers. This series of lectures is supported by the society's John R. Freeman Fund. Other custodians of similar funds are the A.S.M.E. and the A.S.C.E.

The lectures, which start on Oct. 17, 1939, and will be given every Tuesday and Thursday until Dec. 19, 1939, will deal with the theories and natural laws relating to flow of fluids, open-channel problems, the hydraulic jump, propagation of waves in channels, and use of river models. Further information is available from the society.

Successful Joint A.S.M.E.-A.I.M.E. Meeting at Columbus Centered on Coal Utilization

President Christie Proposes Some Research Problems

TWO hundred members and guests of the two engineering societies registered at the joint A.S.M.E.-A.I.M.E. coal meeting at Columbus, Ohio, October 5–7. All the technical sessions were well attended and the papers, judging from discussion and later comment, aroused much interest. A dinner and luncheon added to the social enjoyment of the program, and several trips to points of engineering interest were thoroughly appreciated.

Coal-Mining Methods

Coal-mining methods were the topic of the opening technical session, with three papers covering the latest advances in the development and operation of underground and strip mines. Progress in mechanization, changing conditions, and the development of preparation methods and demands, it is clear, combine to bring about continuous and often radical changes in mining methods. C. A. Gibbons and H. F. Hebley presided over this session, at which Thomas F. Downing, Jr., of the Philadelphia Electric Company, discussed bituminous deep mining, W. C. McCulloch, United Electric Coal Company, spoke on bituminous strip mining, and J. W. Buch, of The Pennsylvania State College, described underground anthracite mining.

Code for Testing Coal Proposed

T. R. Workman, West Virginia Coal & Coke Company, opened the second technical session with a paper on the coordination of fuel engineering from the mine to the consumer, showing how both the coal and coal-consuming industries can be served by efforts along that line. R. L. Rowan, General Coal Company, presented an argument to the effect that a code for testing coal is needed by industry. As a result of his plea, a joint committee was appointed to consider the feasibility of such a code. The paper by William Lloyd, Combustion Engineering Company, which described the development and present status of anthracite burning equipment was presented by Otto de Lorenzi of the same company. He discussed a number of the problems, economic as well as technical, that have arisen as a consequence of progress in that field. L. C. Bosler and D. R. Mitchell served as chairman and vice-chairman, respectively, of the session.

Engineers' Place in Community

The annual stag dinner was held the evening of the first day, with more than a hundred present. C. E. MacQuigg, Ohio State University, presided, introducing those at the speaker's table and the speaker, A. S. Langsdorf, of Washington University. Dean Langsdorf drew on his experiences in smoke abatement in St. Louis to develop the thesis that the engineer has a vital place in the modern industrial community. He made the point that engineers, and other competent groups, must give their assistance freely in working out equitable and sound ways of regulating those phases of industry in which the public is directly concerned. Otherwise, chaos or anarchy on one hand, or a dictatorially regimented existence on the other hand, will inevitably result.

Pulverized Coal and Open Hearths

The morning session of the second day opened under the chairmanship of J. E. Tobey, with A. R. Mumford as vice-chairman. J. P. Kittredge, National Malleable and Steel Castings Company, described the unique pulverized-coal-burning open-hearth furnaces which his company has had in successful operation for many years at Sharon, Pa. His paper is the first technical publication of this important installation. C. C. Russell, Koppers Company, spoke on the measurement of coking pressures, giving details of construction and typical results obtained by means of a moveable-wall oven designed by his company. He stressed particularly the principles and factors involved in the design and conduct of expansion tests.

A. M. Beebe, Rochester Gas and Electric Company, chairman of the Technical Section of the American Gas Association, closed the morning session with a paper on the relationship of coal and manufactured gas. He claimed that, considering the economics of the several major sources of energy, the public interest can be served best now by using gas for cooking, water heating, and refrigeration, coke for heating, and electricity for the other domestic energy requirements.

President Christie Proposes Some Research Problems

At luncheon on October 6, R. N. Tucker, superintendent, Division of Electricity, City of Columbus, introduced the guest of honor, President A. G. Christie of the A.S.M.E. Mr. Christie spoke briefly but most interestingly of some of the research problems whose solution is important to the immediate further advance of central-power-plant engineering: Sulphur removal from coal and from flue gases, ash and slag disposal, flue-dust collecting, and others. He recalled early experiences in Alberta (where, for example, coal at 40 degrees below zero had to be hurried quickly into the furnaces before it could get warm enough to freeze solid!) for several illustrative and amusing stories.

With H. E. Nold and W. G. Christy presiding, P. Nicholls, U. S. Bureau of Mines, opened the second afternoon session by presenting a paper by himself and W. T. Reid, on the viscosity of coal-ash slags. The questions from the floor that followed evidenced the interest taken by fuel engineers in this Bureau research.

Photographs of Combustion Admired

The rest of the session was a veritable symposium on furnace photography. Whether made by professionals or amateurs, taken for this purpose or that, showing the combustion of coal, oil, or gas or the operation of any of a great variety of burners, the four sets of movies, largely in color (some ultraslow motion, some speeded up, and some infrared photos were among those made by A. A. Markson and W. H. Dargan of the Consolidated Edison Company, who presented a paper on the subject of photographic furnace studies) there is no question that all the pictures were highly successful. Some brought out phenomena otherwise undemonstrable, others showed scenes of startling beauty, but the net result was to keep the audience keenly interested until late in the afternoon. Beside those of the Edison Company, pictures from the Windsor Station were shown by Otto de Lorenzi; films of residential stoker fuel beds were shown for S. Konzo of the University of Illinois Experiment Station by L. C. McCabe of the Illinois Geological Survey, and studies of coal, oil, and gas-burning furnaces were displayed by O. F. Campbell, Sinclair Refining Company.

Inspection Trips Complete Program

Saturday, October 7, many of the visitors to Columbus took the opportunity to inspect one or another of the plants of the Columbus Municipal Light Company and the Columbus and Southern Ohio Electric Company, where unusual and up-to-the-minute examples of coal-burning equipment have been installed recently. Others went to the Jeffrey Manufacturing Company, where many modern types of coal-mining and treatment machinery were seen in process of manufacture and in completion. Still others visited the industrial research laboratories of Battelle Memorial Institute and were taken through the various metallurgy, ceramics, chemistry, and physics departments, as well as those laboratories devoted to research on the treatment and utilization of coal.—RALPH A. SHERMAN.

1940 Officers of A.S.M.E. Elected by Letter Ballot

RESULTS of the letter ballot for officers of the A.S.M.E. for 1940 were announced on Sept. 26, 1939, by the tellers of the election, which closed on that date at 10 a.m. The tellers, junior members of the Society, were Arthur E. Blirer, Horace G. Oliver, Jr., and R. F. Warner, Jr.

Out of a total of 3393 ballots returned, 101 were ruled defective by the tellers. Consequently the final results were:

Candidates	*Votes for*	*Votes against*
President:		
Warren H. McBryde	3276	16
Vice-Presidents:		
Kenneth H. Condit	3274	18
Francis Hodgkinson	3279	13
J. C. Hunsaker	3280	12
K. M. Irwin	3278	14
Managers:		
Joseph W. Eshelman	3284	8
Linn Helander	3284	8
Guy T. Shoemaker	3274	18

The new officers will be introduced and installed in office during the Sixtieth Annual Meeting in Philadelphia, Dec. 4–8, 1939.

A.S.M.E. Local Sections 1939–1940 Programs Get Under Way in September With Record Audiences

National Committee of Local Sections Publicity Chairmen Will Aid in Building Up Local Prestige

LOCAL SECTIONS of the A.S.M.E. started off their 1939–1940 programs in September with such fine meetings that the attendance of members and guests far exceeded the fondest expectations of the hard-working program committees. If the reports, which follow, are any indication of the things to come, no A.S.M.E. member can afford to miss one meeting of his Local Section.

Last year, experiments were conducted in several Local Sections on the value of publicity for their meetings. The results—increased audiences, augmented membership, and the building of A.S.M.E. prestige in the community—has led to the organization of a national committee of Local Sections publicity chairmen. Special news releases and publicity hints will be sent periodically to these local chairmen for conducting intensive A.S.M.E. publicity campaigns in their part of the country. It is hoped that this group will be functioning so smoothly by next year that the national celebration of the sixtieth anniversary of the founding of the Society will receive the newspaper space and radio time which it deserves.

Anthracite-Lehigh Valley Has 65 at Berwick Meeting

Berwick, Pa., was the scene of the first meeting of the Anthracite-Lehigh Valley Section on Sept. 22. C. M. Merrick, secretary, reports that E. W. Forkner, speaking on "Ultra-Speed Spot Welding," reviewed various types of resistance-welding techniques, and how a new type of welder satisfies the factors of current, time of application, and pressure.

President Christie Talks to 50 at Central Indiana Meeting

A dinner meeting on Oct. 5 of the Central Indiana Section was the occasion for 50 members, officers of the Section, and faculty members of Purdue University to hear President A. G. Christie talk on "Modern Steam Generators" and Society affairs. His paper and slides stimulated an interesting discussion. Dean A. A. Potter introduced the speaker and Chairman Hans Skabo presided.

Many at Chicago Meeting Learn About Polaroid

Dr. Martin Grabau, manager of the technical division of the Polaroid Corporation, presented an illustrated lecture on Oct. 17 before the members of the Chicago Section about the applications of the new light-polarizing material, Polaroid. The lecture started with a brief review of the nature of light polarization and a description of Polaroid. The remainder of the talk was devoted to a survey of the more interesting applications of polarized light. The Physics Club of Chicago and the Chicago Section of the A.I.E.E. were guests at the meeting.

Cincinnati Has 35 at Sept. 28 Session

The use of electronic tubes was discussed at the Sept. 28 session of the Cincinnati Section which was attended by 35. S. D. Fendley, the speaker, told how the thyratron tube is solving problems in welding, motor control, and light control. The use of the electric eye for color sorting, counting, and numerous other applications was discussed. Many of these applications were demonstrated with working models.

650 Hear Tom Girdler at Cleveland Joint Meeting

T. M. Girdler, chairman of the board of the Republic Steel Co., was the speaker at the Sept. 26 joint meeting of the Cleveland Sections of the A.S.M.E., A.I.E.E., A.S.C.E., and A.I.M.E. His talk dealt with the importance of the engineer in industry. Mr. Girdler also expressed the wish that we keep out of war when he stated that the steel industry wanted peace.

Detroit Has 275 at Meeting on Stamping at Ford Rotunda

Tom Jeffords, secretary of the Detroit Section, reports that the Oct. 3 meeting was held in the Ford Rotunda and attended by 75 members and 200 guests. The speaker, William Longfield, talked on the subject of "Advanced Sheet-Metal Stamping." He discussed the various kinds of presses and how each had been improved by streamlining. An inspection of the Ford plant and a dinner preceded the talk.

Green Mountain Has 80 to Hear Talk by at R. E. Flanders

Gathering on Sept. 25 in the Community House in Springfield, Vt., 20 members and 60 visitors heard a talk on "Thread Grinding" given by Ralph E. Flanders, past-president A.S.M.E.

Dean Kimball Speaker Before Ithaca Section

Dean Dexter S. Kimball, past-president A.S.M.E., and dean emeritus of Cornell University, was the speaker at a meeting of the Ithaca Section on Sept. 29, which was held in the library of Johnson City, N. Y. He told in brief of the different methods used in making bronze castings, both at present and at various times in the past, and concluded by presenting lantern slides of the development of bronzes through the ages.

Kansas City Section Members Pay Visit to Steel Plant

On Oct. 6, 126 members and guests of the Kansas City Section made an inspection trip through the plant of the Sheffield Steel Corporation. Nearly all departments going at full capacity afforded the visitors an unusually interesting trip.

Engineering Congress Papers Before Metropolitan Section

Three papers, that were originally scheduled to be presented at the British American Engineering Congress in New York City, Sept. 4–8, which was canceled because of the inability of the British engineers to come, will be given at meetings of the A.S.M.E. Metropolitan Section. The first paper, "Problems of the Highway User in the United States," will be given by F. C. Horner, assistant to the chairman, General Motors Corporation, at a meeting in room 501 in the Engineering Societies Building on Oct. 31. Thomas H. MacDonald, U. S. Commissioner of Public Roads, will preside.

The second paper, "Some Problems in the Design and Operation of Merchant Ships," is to be presented by its author, Commander Robert C. Lee, vice-president, Moore-McCormack Lines, Inc., at a New Jersey meeting of the Section on Nov. 9, at Stevens Institute of Technology. H. Gerrish Smith, president of the Society of Naval Architects and Marine Engineers will lead the discussion. Chairman of the meeting will be Prof. H. L. Seward, of Yale University.

On Nov. 21 in the Engineering Societies Building the third paper by C. T. Ripley on "High-Speed Lightweight Trains," will be delivered.

Nebraska Hears About Railroad Research

Meeting jointly with the Engineers Club of Omaha on Oct. 4, the Nebraska Section heard Dr. William M. Barr, president of the Club and chief chemical engineer of the Union Pacific Railroad, discuss "Research and the Railroads."

New Orleans Conducts Trip and Meeting

The Sept. 21 meeting of the New Orleans Section was held in the New Orleans Public Service Building, which afforded the members an opportunity to inspect the new high-pressure 35,000-kw unit recently installed. K. P. Kammer, chairman of the Section, appointed several committees during the business part of the meeting, the other part of which was devoted to refreshments.

Oregon Holds Industrial Preparedness Meeting

Oregon Section, in view of the war situation, devoted its Sept. 29 meeting to a discussion by Lieut-Col. John E. Sloan, U.S.E.D., on "Industrial Preparedness," and by Prof. B. S. Ruffner on "Modern Trends in Aviation."

Colonel Sloan's talk dealt with the organization of private industry and the engineering profession for a national emergency and with the work done by the government in studying the Nation's resources and facilities. Professor Ruffner supplemented in detail the Colonel's talk with a discussion of aviation's place in the plans for preparedness.

Pressure Vessels Is Subject of Ontario's Oct. 12 Meeting

"Special Alloy Linings for Pressure Vessels and the Testing and Construction of These Vessels," was the subject of Harry Blumberg, M. W. Kellogg Co., the speaker at the Oct. 12 meeting of Ontario Section.

E. J. Abbott Discusses Surface Finish Before Providence

Just how good is a "mirror finish," is it superior to a "bright," "luster," "high luster," or "superfinish?" These are some of the questions which Dr. E. J. Abbott, Physicists Research Co., answered for the benefit of the members of Providence Section who attended the meeting of Oct. 3, at which he was the guest speaker.

Rock River Valley Speaker Reveals Use of Inferior Woods

Following an inspection of the Forest Products Laboratory in the afternoon of Sept. 21, the 75 members and guests assembled in the evening to hear R. P. A. Johnson, senior engineer of the laboratory. Speaking on "The Use and Abuse of Wood," Mr. Johnson reported that it was found in a survey of home construction throughout the land that deliberate attempts had been made to substitute inferior woods in house construction.

1939 Aeronautic Developments Presented at San Francisco

On Sept. 28 at a meeting of the San Francisco Section, Prof. E. G. Reid, Stanford University, described to 82 members many of the more unusual and important developments of commercial airplanes, some improvements which will probably soon be incorporated into their design, and the newer type of military ships. A motion picture of airplane construction was shown by K. M. Holmgren, of the Boeing School of Aeronautics.

St. Louis Holds Brewery Smoker

There was no need for urging members of the St. Louis Section to be on time for the seventh annual smoker on Sept. 29 at the Anheuser-Busch Brewery Company as guests of A.S.M.E. member Adalbert von Gontard. New Section officers were installed. The floor show was excellent as well as the refreshments and food.

Toledo Pitches Horseshoes and Plays Golf; Yes, Golf

Toledo Section started off the new year by holding a golf and horseshoe tournament on Sept. 16 at the Riverby Golf Club. Chicken and steak dinners were served to players and kibitzers after the tournament.

Virginia Section Meetings Publicized in Daily Press

Virginia Section is doing a fine job in building up its prestige as well as its members through articles in newspapers throughout the Old Dominion State. The executive meeting of the Section, held on Sept. 8, was reported in several newspapers the next day even though it was just ordinary routine business. This business included the selection of G. L. Bascom, chairman of the Section; as representative to the Local Sections Conference, an outline of the program for the coming year, and committee appointments.

Worcester Has Dinner Meeting

Worcester Section held a dinner meeting on Oct. 5 at Worcester Polytechnic. The speaker, Dr. Ernest J. Abbott, discussed before the group of 25 members and 25 guests the subject of "Sounds, Ears, Noises, and Acoustical Measurements and Their Relation to Machinery Quieting." Actual cases in solution of noise problems were presented.

Junior Group Activities

Metropolitan Juniors Outline Objectives at First Meeting

MEETING on Oct. 10 for the first time in 1939–1940, the Junior Group of the Metropolitan Section, A.S.M.E., devoted the program to a discussion of "The Functions and Objectives of the Junior A.S.M.E." With Sam Schoor, chairman of the Group, presiding, the 38 who were present heard talks on the subject by C. K. Holland, D. E. Zeliff, G. L. Lingner, and M. W. Deutschman. Of particular interest was the work of Mr. Lingner's Committee on Vocational Guidance, which is helping young engineers to discover themselves.

As an added feature of the program, motion pictures on Mazda-lamp manufacturing and the Burlington *Zephyr* were shown. In conclusion, each member present was introduced and encouraged to join in the discussion which followed.

New Orleans Juniors Are Very Active and Enthusiastic

ACCORDING to a recent report received from George R. Hammett, secretary-treasurer of the New Orleans Section, A.S.M.E., the Junior Group down there is a very active and enthusiastic organization. Several interesting meetings were held during the summer and on Sept. 28. The officers of the Group are J. K. Mayer, chairman; Waldemar S. Nelson, vice-chairman; Henry Voelkel, chairman of program committee; E. A. McLellan, treasurer; R. B. James, secretary; and J. R. Rombach, Jr., chairman of the membership committee.

San Francisco Juniors Have "Summer" Meeting

IN SPITE of the unprecedented heat wave in California, the third "summer" meeting on Sept. 21 of the San Francisco Junior Group was well attended and thoroughly enjoyed by all present. J. Newbert, assisted by J. Gilman, both of the Pacific Telephone and Telegraph Company, presented talking motion pictures on the activities of their company and its affiliates. The films covered trouble shooting and maintenance in New England after last year's hurricane, research and development on cables, and radio telephony.

Chicago Juniors to Have O. W. Eshbach on Nov. 21

WHAT is the East's loss is the Middle West's gain in having Ovid W. Eshbach available out there for meetings of the Junior Groups. The Chicago Group has taken advantage of the situation by asking Mr. Eshbach, new dean of the Institute of Technology of Northwestern University (see page 851), to be the guest speaker at the Nov. 21 meeting. His subject will be "Opportunities for Young Engineers," which should be of interest to every Junior in the Chicago Section.

Professional Divisions Request Aid of Juniors

IN ACCORDANCE with the action of the Standing Committee on Professional Divisions, Elmo Carruthers, Junior member of the Committee, was empowered to suggest to the Professional Divisions of the A.S.M.E. the advisability of using Juniors in some capacity in their work. So far, all Divisions have indicated that they have definite jobs available for interested Juniors, either as an assistant to the chairman or secretary, a writer of reports, or a member of the committee organized for the purpose of expanding the Division's activities. In answer to a notice which appeared in last month's MECHANICAL ENGINEERING, several applications were received.

Before handing in his final list of Juniors available, Mr. Carruthers wishes all qualified men, particularly aeronautical engineers in Los Angeles, and hydraulic men in Toronto, Ithaca, or Worcester, to send in their applications to Leslie Zsuffa, A.S.M.E. headquarters, 29 West 39th Street, New York City.

With the Student Branches

More Than 300 Attend First Meeting of Purdue Branch to Hear J. W. Parker

Stevens Branch Places Emphasis on Inspection Trips

MORE THAN 300 mechanical-engineering students and faculty members attended the first meeting of the school year of the PURDUE STUDENT BRANCH of the A.S.M.E. in the Purdue Memorial Union on Sept. 21. Featured speaker of the evening was James W. Parker, vice-president of the A.S.M.E., and chief engineer of The Detroit Edison Company. The chairman of the Branch, John Bryan, opened the meeting by introducing the other student officers and Dean A. A. Potter, past-president of the A.S.M.E. Dean Potter welcomed the students to the meeting, and then introduced Lillian Gilbreth, member A.S.M.E., and Vice-President Parker.

"Factors Which Continue to Influence the Power Industry" was the topic of Vice-President Parker. Centering the talk around his own experiences as chief engineer of a large public utility, he discussed the ever-present problems of producing power from steam and how steam turbines are changing so radically and rapidly that a two-year-old turbine is almost an antique. He concluded by showing slides made by his company, including views of turbine development, station equipment, and slag deposits in furnaces.

Radical Change Made by Stevens

The STEVENS STUDENT BRANCH of the A.S.M.E., known on the campus as the Stevens Engineering Society, has had a long and varied history, according to Martin G. Beline, chairman of the Branch. In more than half a century of existence, its purposes, activities, and membership have undergone radical changes. It now places emphasis on inspection trips rather than on the presentation of papers and talks; and admits to membership all students in good standing instead of only upperclassmen as formerly.

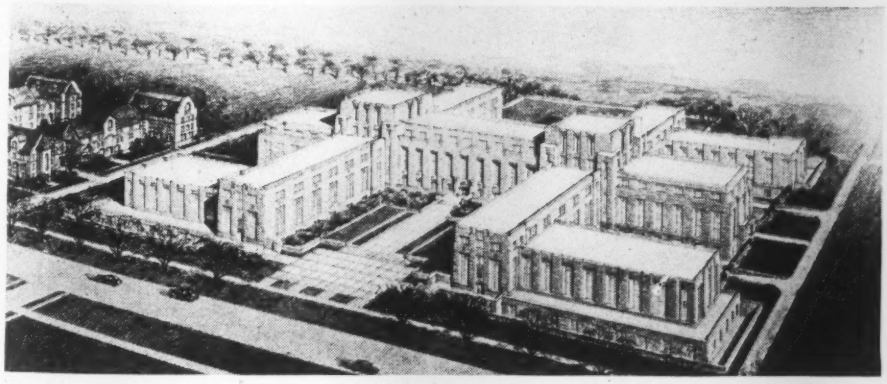
This year the Branch has planned to hold some function at least once every week of the school year. In line with its present policy, it will sponsor inspection trips on Wednesdays to one of the hundreds of industrial plants in the New York area. There will also be motion pictures and prominent outsiders to lecture to the members. As in the past, refreshments will be served after the evening meetings. The first inspection trip of the year was made on Sept. 27 to the Western Electric plant at Kearny, N. J. About 40 student members took part.

First Meeting of British Columbia

Roy Bogle, chairman of BRITISH COLUMBIA BRANCH, opened the first meeting of the school year on Sept. 27, by telling the 30 students present of the advantages of membership in the Branch. It may be noted here that the Branch at the University of British Columbia is the newest baby in the family of A.S.M.E. Student Branches.

California Has Hot Banquet

UNIVERSITY OF CALIFORNIA BRANCH had a turnout of almost 100 for the annual initiation banquet, Sept. 21, despite the severe heat wave under which that part of the country suffered. After silencing the soup-music makers, Chairman Ronald Slipper asked George Hays to award the prizes to the more ingenious of the neophytes for their efforts as poets and inventors. Then the master of ceremonies for the evening, Prof. L. K. Boelter, took over by introducing Prof. B. M. Woods, who talked on the government's training program of college students as airplane pilots. Professor Woods is chairman of the committee in charge of the program at the University.



ARCHITECT'S SKETCH OF NORTHWESTERN TECHNOLOGICAL INSTITUTE

(To be started about January, 1940, and completed in September of that year. It will enable the Institute to take care of a total enrollment of 800 in civil, chemical, electrical, and mechanical engineering.)

80 at Brooklyn Poly Meeting

BROOKLYN POLY BRANCH held its first meeting of 1939–1940 on Sept. 27. W. J. Abokair, chairman of the Branch, presided. Prior to a talk on the advantages of membership in the A.S.M.E., the 80 members discussed the possibility of taking an inspection trip to Boston.

C.C.N.Y. Shows Motion Pictures

C.C.N.Y. BRANCH at its first meeting on Oct. 5, showed motion pictures on valves, before a group of about 30 members. During the first week of school, 28 new members have joined the Branch. Plans for the future call for an induction smoker, laboratory dance, and various speakers on technical topics.

Clarkson Has Record Membership

CLARKSON BRANCH met on Sept. 27 for its first meeting of the school year. A brief talk on the objectives of the Branch was given by Chairman Robert Walser. At this meeting, attended by 50, Secretary Woodrow C. Nellis reports that 35 new members were signed up. Last year's total membership was 25.

Student Papers at Colorado

COLORADO BRANCH opened its first meeting on Oct. 4, by having Maynard J. Warneke give a talk on his visit during the summer to the Grand Coulee, Hoover, and Coolidge Dams, and getting W. William Lewis to tell of his experiences in working for the Lockheed Aircraft Corp. during the summer. The attendance was 44.

Films at Georgia Tech

GEORGIA TECH BRANCH devoted most of its meeting on Oct. 3 to the showing of a motion picture on the methods and application of a new welding process developed by the Linde Air Products Co. Following the showing, R. E. Mason was elected to represent the Branch on the school's engineering committee. The audience consisted of 51 members and 26 visitors.

Officers Elected at Iowa

IOWA BRANCH elected the following officers at the first meeting on Sept. 27, which was attended by 60 members: J. P. May, chairman; R. P. Miller, vice-chairman; and H. L. Yakish, secretary-treasurer. Prof. Henry L. Godeke was introduced as the new honorary chairman.

130 Attend Iowa State Pow-Wow

IOWA STATE COLLEGE BRANCH opened the 1939–1940 year with the annual Pow-Wow and student mixer. The high light of the evening's

entertainment was having the 130 present smoke the ancient Indian peace pipe. Professor Breckenridge, custodian of the pipe, in the full regalia of an Indian chief related the tale of how the conclave of chiefs gave him the clay pipe to take back to Ames, Iowa, for the student members to smoke at their first meeting. Group singing and real singing by the Y.M.C.A. quartet followed and the program was concluded with the serving of refreshments.

A.S.M.E. Smoker at Kansas

KANSAS BRANCH opened its program for the year with a smoker on the evening of Sept. 28. After Professor Hay called the attention of the 50 members to the cash prizes available to them from the A.S.M.E. Kansas City Section and the Kansas Engineering Society, Dean Crawford spoke on the value of being a member of an engineering society. The meeting was adjourned for cider and doughnuts.

New Kentucky Officers

KENTUCKY BRANCH met on Sept. 29, to elect the following officers: Ted Cozine, chairman; W. C. Wilson, vice-chairman; Tom Jackson, secretary; and Fred Fischer, treasurer. Installation of the new officers of the branch followed.

Wrought Iron Discussed at Lehigh

LEHIGH BRANCH had as speaker on the evening of Sept. 29, Dr. James Aston, consulting metallurgist, who presented a very interesting and constructive talk and motion picture on the manufacture of wrought iron.

Lewis Has 60 at Meeting

LEWIS BRANCH met for the first time this school year on Oct. 4. There was an attendance of 60.

Important Doings at L.S.U.

LOUISIANA STATE BRANCH certainly transacted a lot of business at its Sept. 27 meeting. The members voted to have the Branch subscribe to *Life*, *Esquire*, *Power-Plant Engineering*, *Aero Digest*, and the New Orleans *Times-Picyune*, in order to make it possible for members to round out their reading program. It was further decided to waive the dues of one member in return for his acting as janitor of the Branch's meeting room. The only new equipment voted this year for the meeting room was a pencil sharpener. Finally, plans for inspection trips and student speakers at meetings were discussed.

MEMBERS AND FACULTY ADVISERS OF THE A.S.M.E. STUDENT BRANCH AT THE UNIVERSITY OF NEW MEXICO

Maryland Doubles Membership

MARYLAND BRANCH met on Oct. 3 to hear a talk on membership in the Branch by Prof. J. E. Younger. Francis C. Morris reports that compared to last year's membership of 26, there are already signed up for this year 47 new and old members.

Michigan Has Reunion Night

MICHIGAN BRANCH's meeting on the evening of Oct. 4 was almost like a reunion. With 40 members and 50 guests present, the Branch had as its guest Prof. R. S. Hawley, who did his bit for the Branch 15 years ago as honorary chairman. To add a more modern note, Chairman Ray Jones introduced Prof. E. T. Vincent, this year's honorary chairman. Representing the A.S.M.E. Detroit Section was John Shecter.

MICHIGAN TECH A.S.M.E. STUDENT BRANCH MEMBERS HAD THEIR PICTURE TAKEN IN JUNE, 1939, FOR THE CLASS BOOK

Lots of Smoke at Michigan Tech

MICHIGAN TECH BRANCH created a lot of smoke and good cheer with its smoker on Oct. 11. Besides the smokes, there were refreshments, movies, and other entertainment.

Trip Movies at Mississippi State

MISSISSIPPI STATE BRANCH members and guests, numbering 100, met on Sept. 26, to see the motion pictures that were taken during a geology trip to the West by students of the College.

Faculty Humanized at Minnesota

MINNESOTA BRANCH acted as host to students on Oct. 10 at a rally which featured a preview of the coming year's program, a talk on "Humanizing the Faculty," introduction of the poor berated faculty, and a membership campaign which used as its lure souvenirs and refreshments.

Missouri Mines Meets With 52

MISSOURI SCHOOL OF MINES BRANCH met on Sept. 26 with an attendance of 52. Ray E. Vaughan was elected to fill the vacant position of treasurer.

Nevada Goes in for Flying

NEVADA BRANCH at its meeting of Sept. 19 authorized Walter Elkins to look into the matter of making arrangements to teach the members how to fly. He is to report at the next meeting.

N.Y.U. to Give Doctorates

N.Y.U. BRANCH will be able to increase its graduate membership because of the new program instituted by the University which makes it possible to confer the degree of Doctor of Engineering Science. At present there are

THE BOYS TURN OUT ON OCTOBER 2 FOR THE FIRST MEETING OF 1939–1940 OF THE A.S.M.E. STUDENT BRANCH AT THE UNIVERSITY OF TEXAS

14 candidates for the new degree and more than 100 for the other graduate degrees.

Committees at North Dakota State

NORTH DAKOTA STATE BRANCH met on Oct. 3, at which time Chairman Arthur Hewitt announced the appointment of the following members to committees: Bill Arnold, James Christenson, and Harvey Snyder to Membership Committee, and K. Loftheim, Bob Whemner, and G. Baken to the Program Committee.

Favorable Reactions at Notre Dame

NOTRE DAME BRANCH met on Sept. 26. Robert Witchger, secretary of the Branch, reports that "20 new members were enrolled, favorable reactions were shown by the remaining 15 attendees."

Welding Movies at Pratt

PRATT BRANCH members, numbering 76, met on Sept. 28 for the first meeting of the term. Motion pictures of welding were shown to the assemblage.

R.P.I. Has Free Smokes

RENSSELAER POLY BRANCH had 81 members and guests present at the Oct. 4 meeting, the first one of the semester. The large attendance was due either to the offer of free smokes or the excellent motion picture, "Heat and Its Control." Anyhow, every one had a fine time.

Rose Has 100 Per Cent Membership

ROSE TECH BRANCH, following its meeting of Sept. 19, reports that all eligible students have joined. Congratulations to Chairman Norman Eder, Secretary Fred Thodal, and the other officers.

Texas Learns That A.S.M.E. Membership Is Worth $314

TEXAS BRANCH met for the first time this semester on Oct. 2. Thanks to W. R. Woolrich, Jr., secretary of the Branch, for reporting that Prof. V. L. Daughtie stated that financial returns offered to an A.S.M.E. student member amounted to $314 if he took advantage of the various rewards, loans, and publications that the National Society offers students. Nonfinancial rewards include contact with fellow students and practicing engineers, self-expression in preparing and presenting papers, and opportunities to attend meetings and to serve the University. As a result of this talk and the visits of officers to dormitories and boarding houses, 53 students applied for membership.

Vermont Holds Banquet

VERMONT BRANCH, an up-and-coming organization, held its first annual banquet on Oct. 11. Members of the Banquet Committee consisted of M. L. Newton, W. E. Young, and K. M. Grout.

Virginia Meets First Time

VIRGINIA BRANCH members met on Sept. 26 and heard various speakers explain as to what goes on at meetings, what material is presented, and in general how the A.S.M.E. helps student members.

102 at Virginia Poly Meeting

V.P.I. BRANCH held its first regular meeting on Sept. 29. There was an attendance of 64 members and 38 visitors. Dean E. B. Norris talked on "What Membership in the A.S.M.E. Means to You," followed by Prof. J. B. Jones and Honorary Chairman F. S. Roop.

Wisconsin Meeting Attracts 150

WISCONSIN BRANCH had such a well-attended meeting on Sept. 28, that Robert E. Wright, secretary of the Branch, predicts that out of the 150 present, at least 70 should become members. Membership last year was only 43.

Rutgers University Offers Home-Study Courses

HEATING and ventilating and air conditioning are still among Rutgers University's most popular home-study courses, according to a statement by Prof. C. G. Gaum, secretary of the University's extension division. Not only concerns in the afore-mentioned industries, but the public utilities, make use of these courses, some of them even conducting upon their own premises classes for groups of students enrolled in the home-study courses and supervising the work with their own engineering staffs. Full information regarding all of its extension courses may be obtained by addressing, University Extension Division, Rutgers University, New Brunswick, N. J.

Talks at Michigan on New Transportation Technologies

SCIENTISTS, research men, and technicians from the laboratories of the great industrial corporations, governmental bureaus, research foundations, and leading national technical schools will gather at Ann Arbor, Michigan, Nov. 1, for the "University of Michigan-*Life* Conference on New Technologies in Transportation," it was announced by H. C. Anderson, member A.S.M.E., Dean of the College of Engineering. Speakers at the three-day gathering will include Charles F. Kettering, member A.S.M.E., vice-president in charge of research, General Motors Research Corporation; C. R. Smith, president, American Air Lines, Inc.; Fred M. Zeder, member A.S.M.E., vice-chairman of the board, Chrysler Corporation; and many others.

Sponsored jointly by the University of Michigan and *Life* magazine, the conference is described as "designed to examine new methods, new materials, and new directions in the transportation field," dealing with aspects of engineering, metallurgy, thermodynamics, structures, tensile strength, speed, and capacity in the fields of air transportation, automotive, highway, rail, and marine transportation. Simultaneously a series of round-table discussions will deal with specific 1939 achievements in the respective fields, including metals, alloys, plastics, and lubricants.

A.S.M.E. Calendar

of Coming Meetings

November 2–4, 1939
Joint Meeting with American Institute of Physics in a Symposium on Temperature Measurement, New York, N. Y.

December 4–8, 1939
Annual Meeting
Philadelphia, Pa.

May 1–3, 1940
Spring Meeting
Worcester, Mass.

June 17–21, 1940
Semi-Annual Meeting
Milwaukee, Wis.

(*For coming meetings of other organizations see page 22 of the advertising section of this issue*)

Hoover Medal for 1939 Awarded to Gano Dunn

GANO DUNN, member A.S.M.E., and president of Cooper Union and the J. G. White Engineering Corporation, has been chosen as the 1939 recipient of the Hoover Medal, "awarded by engineers to a fellow engineer for distinguished public service," it was announced by John V. W. Reynders, chairman of the Hoover Medal Board of Award which

Bach Bros.

GANO DUNN

has representatives from the four Founder Engineering Societies, following a meeting of the Board on Sept. 20, 1939. The medal will be formally presented to Mr. Dunn under the auspices of the American Institute of Electrical Engineers during the annual meeting of the Institute in New York City, Jan. 22–26, 1940.

Mr. Dunn is the fourth Hoover Medalist. The first was Herbert Hoover, former president of the United States and honorary member of the A.S.M.E., to commemorate whose civic and humanitarian achievements the medal was instituted in 1929 by gift of Conrad N. Lauer, fellow A.S.M.E.; the second was Ambrose Swasey, past-president and honorary member of the A.S.M.E., and founder of The Engineering Foundation; the third was John Frank Stevens chief engineer of the Panama Canal.

The members of the 1939 Board of Award, and the Societies which they represent, are: Albert S. Crane, Ralph Budd, A.S.C.E.; Clinton H. Crane, John V. M. Reynders, Scott Turner, A.I.M.E.; Conrad N. Lauer, William H. Kenerson, Stephen F. Voorhees, A.S.M.E.; and A. W. Berresford, Howel H. Barnes, Jr., William McClellan, A.I.E.E. Also a member, representing the A.S.C.E., was Thaddeus Merriman, who died on Sept. 26.

Mr. Dunn participated in the organization of The Engineering Foundation, of which he was its first chairman, 1915–1916, and long a trustee, and of the National Research Council of the National Academy of Sciences, of which he was chairman from 1923 to 1928. He was president of the United Engineering Societies from 1913 to 1916, of the A.I.E.E. in 1912, and of the New York Electrical Society from 1900 to 1902. From 1916 to 1918, he was a member of the War Department Nitrate Commission, and chairman and disbursing officer of a special committee of the State, War, and Navy Departments on Submarine Cables in 1918. He was also a member of the engineering committee of the Council of National Defense. For many years he has been chairman of the visiting committee of the National Bureau of Standards, a statutory body, and he was a member of the executive committee of the World Power Conference of 1936, at which he represented the State Department. He is also a member of the Patent Office Advisory Committee, President's Committee on Civil Service Improvement, and the Science Advisory Board of the government.

In 1937, Mr. Dunn received the Thomas A. Edison Medal of the A.I.E.E. "for distinguished contributions in extending the science and art of electrical engineering, in the administration of great engineering works, and for inspiring leadership in the profession."

Plastics Booklet Proposed by Special A.S.M.E. Committee

AN OUTLINE of a proposed booklet on plastics was discussed by representatives of the Special Committee on Plastics and Rubber of The American Society of Mechanical Engineers on Oct. 3, following the Society of Plastics Industries meeting at the Westchester Country Club. The publication, which is intended primarily for engineers and students in engineering schools, will be divided into four parts, namely, materials, molding and finishing, applications, and properties and testing. Another division of the booklet will similarly consider the subject of rubber and rubberlike materials. Felix Yerzley, C. S. Stillwagon, H. S. Spencer, Spencer Palmer, E. F. Lougee, and G. M. Kline participated.

British Engineers Honor Two A.S.M.E. Members

IN CONJUNCTION with the British American Engineering Congress, which was to be held in New York City, Sept. 4–8, 1939, but had to be canceled on account of the European situation and the inability of The Institution of Mechanical Engineers to meet with The American Society of Mechanical Engineers, both Societies planned to confer honorary memberships on outstanding engineers in the country of the other Society. According to word received recently, the two American mechanical engineers selected to be awarded honorary life memberships in the Institution were Alexander G. Christie, president of the A.S.M.E., and Henry Ford, member A.S.M.E. Engraved membership certificates signed by the president and secretary of the Institution have been sent to the A.S.M.E. to forward.

State Engineering Examiners Elect 1939–1940 Officers

THE following officers were elected at the 20th annual convention of the National Council of State Boards of Engineering Examiners held in San Francisco during July, to serve the Council for 1939–1940: President, A. C. Polk, Alabama; vice-president, Virgil M. Palmer, member A.S.M.E., New York; past-president, Charles F. Scott, member A.S.M.E., Connecticut; directors, J. H. Dorroh, New Mexico, C. C. Knipmeyer, Indiana, and W. W. Hodge, West Virginia.

Return of Membership-List-Data Card Urgent

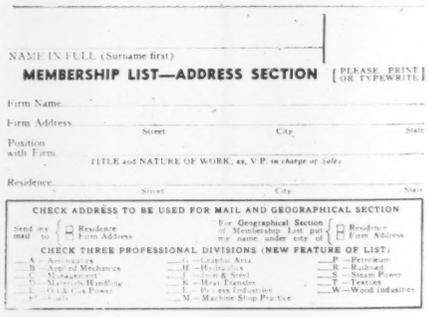
1940 A.S.M.E. List Will Have Two New Features

TWO NEW FEATURES, to be added to the 1940 A.S.M.E. Membership List, make it important for every member and junior of the Society to fill out and return to Society headquarters, if he has not already done so, the data cards sent out from headquarters on October 10. The Membership List is scheduled for publication in February, 1940. Inasmuch as no list has been published since February, 1937, it is particularly important that the Society records be checked against the data requested.

For the first time, the Membership List will indicate the Professional Divisions in which each member is registered. Unless a member returns the data card sent him and on it checks the three divisions in which he wishes to be registered, no information on this point will be included in connection with his name. A prior registration by him will not be used.

The second feature to be added for the first time concerns only members engaged in independent professional practice. The A.S.M.E. Council has authorized a new section of the List which will consist of a geographical index in which all A.S.M.E. members engaged in independent professional practice will be listed, without charge, provided they fill out and return the card sent out October 10 with the Membership-List-Data card.

With the Membership List, which will contain the names of all members in good standing on December 1, will be combined the section of the Society Records containing the 1940 Council and committee personnel and other general information, so that the one issue will cover all of this reference material. It will also be the first time that hundreds of members and juniors elected to membership in the Society will have themselves listed with the 15,000 other members of the Society.



NAME IN FULL (Surname first)

MEMBERSHIP LIST—ADDRESS SECTION [PLEASE PRINT OR TYPEWRITE]

Firm Name

Firm Address ... Street ... City ... State

Position with Firm ... TITLE and NATURE of WORK, as, V.P. in charge of Sales

Residence ... Street ... City ... State

CHECK ADDRESS TO BE USED FOR MAIL AND GEOGRAPHICAL SECTION

Send my mail to { ☐ Residence ☐ Firm Address } For Geographical Section of Membership List put my name under city of { ☐ Residence ☐ Firm Address }

CHECK THREE PROFESSIONAL DIVISIONS (NEW FEATURE OF LIST)

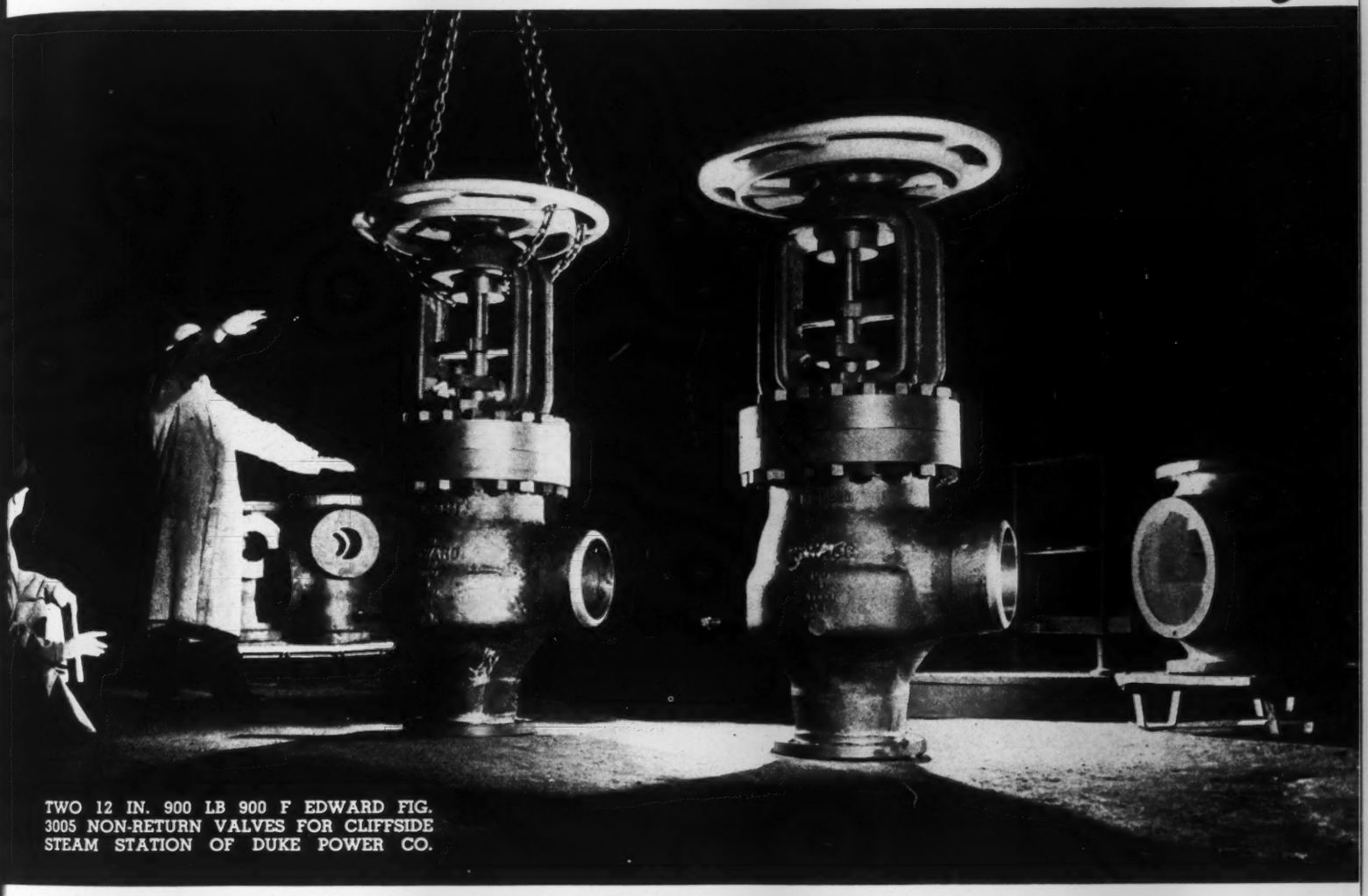
A—Aeronautics ... I—Graphic Arts ... P—Petroleum
B—Applied Mechanics ... H—Hydraulics ... R—Railroad
C—Management ... J—Iron & Steel ... S—Steam Power
D—Materials Handling ... K—Heat Transfer ... T—Textiles
E—Oil & Gas Power ... L—Process Industries ... W—Wood Industries
F—Fuels ... M—Machine Shop Practice

COPY OF CARD WHICH MUST BE RETURNED BY EVERY A.S.M.E. MEMBER

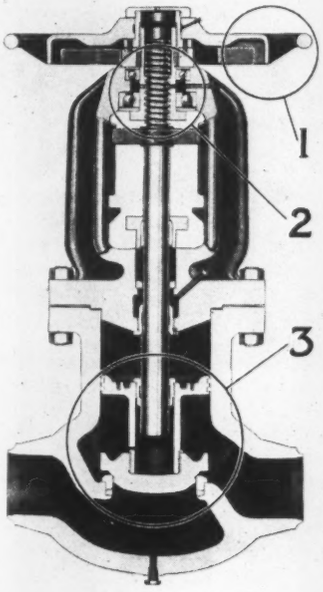
One last warning. Don't *forget to put your name on the return card! Some have!*

(A.S.M.E. News continued on page 856)

..and, best of all, Edward Non-Return Valves Save Money



TWO 12 IN. 900 LB 900 F EDWARD FIG. 3005 NON-RETURN VALVES FOR CLIFFSIDE STEAM STATION OF DUKE POWER CO.



THREE EDWARD WINNERS

Designed for tomorrow's record-setting power plants, new Edward non-return valves embody refined but time-tried basic principles worked in with new but proved materials. Cross section shows three valuable details—(1) Impactor handwheel, (2) EValthrust yoke bushing, and (3) hourglass disk-piston assembly. Edward Impactor handwheel is a "must" auxiliary for speedy emergency operation and for leakless closure during boiler tests. EValthrust yoke bushing, with angular thrust ball bearings, is distinctively of globe valve origin. Cut shows a Stellited seat welded in the globe body.

WHEN you install Edward non-return valves you do more than post sentinels at the outlet of steam generating units. These valves, used predominantly in high pressure boiler plants throughout the land, meet all routine needs in the way of preventing back flow or of providing positive shut-off when the boiler is down. They are available for all working conditions, are often adopted to good effect for unusual flow control problems in technological processes and, best of all, they save money by their freedom from operating trouble, low up-keep cost, and minimum pressure drop. Every Edward non-return valve embodies the essentials of free flow areas, open self scouring guides, EValloy piston rings, integral dashpot with freedom from differential thermal expansion problems, and hourglass pistons. These features characterize the two welding end valves above, photographed before removal of inlet test flanges. On your next job, specify Edward valves.

THE EDWARD VALVE & MFG. CO., INC.
EAST CHICAGO INDIANA

EDWARD Valves

STOP • CHECK • BLOW-OFF • NON-RETURN

J. P. Hogan Nominated President of A.S.C.E.

J. P. HOGAN

JOHN P. HOGAN, member A.S.M.E., consulting engineer of New York, and chief engineer and vice-president of the New York World's Fair, 1939, Inc., was nominated Oct. 6, for the presidency of the American Society of Civil Engineers. Colonel Hogan has been engaged in engineering work, largely in the development and utilization of electric power, since his graduation from Harvard University in 1904, being employed in the construction of the first subways in New York City, later being division engineer on the Catskill Aqueduct for the New York Board of Water Supply, and a member of the marketing board of the St. Lawrence Power Development Commission and the Delaware River survey committee of the U. S. Government. In his present position with the New York World's Fair, he has been personally responsible for the planning, construction, and engineering of this great undertaking of modern times.

Upon the entry of the United States into the World War in 1917, he served two years in France in grades from captain to lieutenant-colonel of engineers on the General Staff. For his war service, he received the Distinguished Service Medal, the Legion of Honor, the Conspicuous Service Cross (New York State), and the Order of the Purple Heart.

Woman's Auxiliary to Hold Scholarship-Fund Party

THE New York Section of the Woman's Auxiliary to the A.S.M.E. is planning to hold a dinner meeting and grand party at the Engineering Woman's Club, 126 E. 35th St., New York City, at 7 p.m., Tuesday, Nov. 7, 1939, in order to raise money to establish a scholarship fund to aid needy senior students of mechanical engineering to finish their last year in college. Mrs. L. M. Gibson, chairman of the Ways and Means Committee, with headquarters at the above address, states that tickets for the party are only $2 each, and suggests that if an engineer cannot attend a contribution to the fund would be very welcome. Other members of her Committee are Mrs. George Gladden, Mrs. C. H. Young, Mrs. R. B. Purdy, Mrs. C. B. Le Page, Mrs. A. D. Blake, Mrs. Crosby Field, and Mrs. G. W. Farney, *ex officio*.

The monthly meeting of the Auxiliary will be held on Thursday, Nov. 9, at the Engineering Woman's Club with the executive committee meeting in the morning at 11 a.m. and the entire membership in the afternoon at 2 p.m. Arrangements are being made to have a very interesting speaker.

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE[1]

PRODUCTION EXECUTIVE, M.I.T. graduate, ten years railroad and municipal construction; 11 years production of evaporated and rock salt; last 4 years engaged in economic research. Me-378.

MECHANICAL ENGINEER, 24 years' experience machine design, chemical-plant design, supervision, machine-shop management, sales experience as manager engineering and sales of air and gas compressors. Qualified engineering executive with excellent record. Me-379.

MECHANICAL ENGINEER, graduate of Georgia Tech., 1937, desires mechanical work. Experience in maintenance in rayon plant, including machine-shop, electric-motor, and pipe-fitting work. Location and salary of secondary importance. Me-380.

MECHANICAL ENGINEER, 22, graduate M.E., 1939. Four summers' industrial experience; 11 months' experience research and experimental, part-time work. Desires work or training course leading to permanent mechanical-engineering position. Me-381.

MECHANICAL ENGINEER, 23, single, graduate Pratt Institute, 1939. Willing to consider any opportunity. Preference for drafting and machine-tool design. Available at once. Location immaterial. Me-382.

RECENT GRADUATE MECHANICAL ENGINEER, with some experience in drafting. Salary unimportant. Interested in sales, but will work in any capacity that offers opportunity to learn engineering. Any location. South preferred. Me-383.

ENGINEER, 38, married, graduate, licensed. Fifteen years' varied design, construction, research, sales, executive experience in industrial plants, heating, ventilating, refrigeration, air conditioning. Now employed, available on reasonable notice. Me-384.

MECHANICAL ENGINEER, 30, married, B.P.I. graduate. Five years' plant superintendent, complete charge operations. Post-graduate courses: Air-conditioning, refrigeration, power-plant industries. Salary secondary to opportunity. Location preferred, East. Me-385.

POSITIONS AVAILABLE

Opportunities for power-plant designers and draftsmen are open in New York area.

GRADUATE MECHANICAL ENGINEER, 35–45, with at least 5 years' experience as works manager of metal-working plant having as part of processes metal stamping, deep drawing, and polishing. Experience in pressed-metal field is essential. Experience in non-ferrous foundry work would also be desirable. Applicant must show successful record of accomplishment as works manager of company now in good standing, and be employed at present time. Salary, $7500–10,000 a year. Location, New England. Y-3608.

[1] All men listed hold some form of A.S.M.E. membership.

ASSISTANT GENERAL MANAGER, under 40, with proved record of accomplishment with recognized company engaged in manufacturing of automotive lines. Applicant must have appearance and personality to meet important executives. Should be able to handle labor, factory operation, administrative work, sales engineering; to make customer contacts in the field and get new business, particularly in metal-stamping trade. Salary, $7000–$10,000 a year or over. Location, Middle West. Y-4137C.

GENERAL SALES MANAGER with experience in field of metal stampings. Location, New England. Y-4524.

GRADUATE ENGINEER to act as manager of plastic department. Must have sufficient experience to take charge of plastic department, with exception of engineering and costs. Should be familiar with latest methods of injection plastics molding. Salary, $250–$325 a month. Location, Middle West. Y-4720C.

CONSULTING ENGINEERING FIRM, for over 20 years serving gilt-edged clientele in industrial power-plant and refrigeration field, offers unusual opportunity to financially responsible graduate engineer, with 5 to 10 years' engineering experience, to purchase interest in firm and take active part in broadening clientele. Must possess personality and technical knowledge for this duty. Attractive opportunity for engineer possessing qualifications for dignified career in consulting profession to become actively identified with highly reputable and long-established firm. Reply should reflect sales ability. Location, New York, N. Y. Y-4721.

ASSISTANT CHIEF MECHANICAL ENGINEER, 35–50, with experience in design of high-pressure and low-pressure locomotive-type boilers. Must have thorough knowledge of welding for high-pressure boilers. Location, Middle West. Y-4724C.

STEAM POWER PLANT ENGINEER to take full charge of operation and maintenance of plant containing 375-lb Vickers turboalternators of 12,500 kw capacity, 5 B.&W. oil-fired water-tube boilers with Worthington Simpson Cooling towers, 180-lb turboalternator (English electric) with surface condenser, capacity 500 kw. Position will last one or two years. Location, Mexico. Y-4727.

ASSISTANT OR ASSOCIATE PROFESSOR, 30–40, with master's degree in mechanical engineering. Must have several years' experience in internal-combustion-engineering design. Must be familiar with latest development in machine design, advanced thermo as applied to internal-combustion engineering and basic theory in lubrication. Knowledge of heat transfer necessary. Should be good laboratory man. Salary, $3000–$4000 a year. Y-4739.

GENERAL MANAGER, 40–50, with executive background, to take charge of large manufacturing company. Should have knowledge of enamelware manufacture or present-day foundry practice, and be thoroughly familiar

(A.S.M.E. News continued on page 858)

Photo courtesy Remington Rand, Inc.

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